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Forthcoming Events.

NOVEMBER 29.

Institution of Mechanical Engineers (Birmingham Branch):—Ordinary meeting in London. "Metal Rolling and the Influence of Cooling on Plastic Flow," Paper by J. E. Fletcher.

NOVEMBER 30.

Institute of Marine Engineers:—Annual dinner at Hotel Cecil.

DECEMBER 1.

Birmingham Metallurgical Society:—Annual dinner.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "The Use of Refractories in the Foundry," Paper by H. Winterton.

DECEMBER 3.

The Birmingham Metallurgical Society:—Ordinary meeting at Wednesbury. "Mechanical Properties of Metals at Elevated Temperatures," Paper by D. H. Ingall, M.Sc.

Institute of British Foundrymen (Falkirk and District Branch):—Ordinary meeting at Falkirk. "Foundry Sands," Paper by H. Cowan, B.Sc.

Institution of Automobile Engineers:—General meeting at Loughborough. "Misuse of the Internal Combustion Engine, and Suggestions for its More Efficient Application," Paper by L. Murphy.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

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The Effect of Protective Tariffs on the Foundry Industry.

We are perfectly well aware that we are treading on dangerous ground in dealing with such a subject, as, unfortunately, it has been made a political issue. We propose, however, to attempt to visualise the effect of the imposition of tariffs on imports on the foundry trades of Great Britain. Assuming that tariffs will benefit some trades and act adversely on others, it cannot be said that it will have a universal effect on the foundry trades, as they supply some raw material for every branch of industry, including engineering, shipbuilding, textile, agriculture, automobile, building trades, chemical and metallurgical industries. The immediate raw materials for the ferrous foundry industry are all domestic, only a certain amount of iron ore for the manufacture of pig-iron being imported. A fair quantity of Continental pig-iron is imported from time to time. The foundry employs and is employing more and more machinery for transport, furnace equipment, moulding machines, and fettling shop tools. Most of the transport machinery is of domestic manufacture, as is also the furnace and fettling shop equipment, but a large percentage of the moulding machines are imported. There is little reason to doubt, however, that such machines will, if taxed, be manufactured in Great Britain.

The next question is the amount of business British foundries would hope to get from the lessened competition from imported material. The largest issue, of course, is that if foreigners erect factories for making machines at present imported foundries are bound to receive orders, but that is indirect, and may be controversial. It is with direct business with which we are concerned. Starting with grey iron first. Whilst the Board of Trade figures, however analysed, are not too impressive, one would like to transfer the making by Belgians of large turbo-casings to British foundries, for no great numbers are required and the experience gained for every one made is a national asset. Taking 6,000 tons as a normal figure and spreading it over the entire British industry, it does not appear that this is likely to affect the average foundry very much. Obviously the indirect considerations of imported machinery have a larger bearing.

With steel castings, however, British foundrymen do feel foreign competition fairly badly, especially as it relates to light steel castings. Though, say, only about 5,000 tons are imported annually, it must be remembered that for every steel foundry there are more than ten iron foundries, and this extra work, whilst possibly insufficient directly to influence a balance-sheet, it would be a useful increment from which extra experience would be gained.

For malleable iron castings the Board of Trade returns do not give any separate figure. They are probably included in various items such as electrical fittings, hardware and the like, but we believe the figure would be fairly formidable. At any rate, it is at present worth while for at least one large American foundry to maintain a London office to handle its business in this line. Any help which a tariff system could give to the British malleable industry would be welcome, as, with some notable exceptions, the firms constituting this section of the industry are not making real progress. It would probably necessitate a change over from Reaumur to blackheart, and it would expand a business which is still too small and little understood.

Finally, there is the non-ferrous castings business, but this is so overshadowed by the influence

of raw materials that in trying to visualise any effect of protection one must turn to this question mainly for enlightenment.

Finally, so far as the Board of Trade figures are concerned, they must be accepted as not representing the true situation with respect to the amount of foreign castings entering Great Britain, as many are included in other categories, such as hardware and fittings of various classes.

It must be distinctly understood that this article is not meant to be an endeavour to make any propaganda, but is just an honest attempt to visualise the effect of protective tariffs on our own industry so far as they would be directly operative.

Dirty Steel.

The endurance work of the Bureau of Mines Field Station at Ithaca, N.Y., has given results which in general fit in very well with the recent work of the engineering experiment station of the University of Illinois, and which indicate that the conclusions of the Illinois investigation may be extended to apply to a large range of alloy steels.

But, beside corroborating and extending the Illinois results, the work of the Bureau has brought out a point which has not been covered completely by other investigators in this country or abroad, although it has been considered to some extent by most workers in this field. This point is the evil effect on endurance of non-metallic inclusions. Dirty steel gives far less uniform results on endurance tests than cleaner steel, and dirty steel is certainly unreliable and unsafe where repeated vibration must be endured.

These inclusions, or other similar hetrogeneities in the metal, are probably the cause of many failures in service. From the relationship worked out by the Illinois investigators and others, and corroborated by the Bureau of Mines tests, the endurance properties of any really clean steel may be quite safely predicted. But when the steel is not clean, it may either give the same results as a clean steel, or far poorer results, depending on whether the most severely stressed spot in a piece made from the dirty steel happens to be locally clean or locally dirty.

The problem of the exact effect of different inclusions or hetrogeneities in steel and other alloys, and the larger problem of how to produce clean steel and alloys, are of vital importance, and involve many factors in the preparation of metallic products, ranging from the methods of elimination of impurities from the ores down through the smelting of the metals and the melting of the alloys. Much scientific data needed for a proper understanding of the problem are lacking.

To obtain further information on the effect of inclusions, comparisons are being made of endurance tests on specimens cut both with and across the direction of rolling, since the latter, or transverse specimens, usually show the bad effect of inclusions and hetrogeneities most markedly.

As soon as the endurance tests on the series of molybdenum, cerium and comparison steels are completed, tests will be made on a series of nickel-silicon steels previously made by the Bureau of Mines for the Navy, on which tests made by the Navy on properties other than endurance are available. The Navy has supplied specimens cut both longitudinally and transversely, and the bureau has prepared all these specimens for testing. This work should throw some light on the problem of inclusions. But work with inhomogeneities such as inclusions in steel is difficult because of the irregularity of distribution of the inclusions.

In order to study the effect of different kinds of hetrogeneities in different sorts of alloys, work on certain non-ferrous alloys has been begun.

Prior to the fiscal year of 1922-1923 a series of 50 molybdenum, cerium, and other alloy steels was prepared for comparative purposes, in co-operation with the Vanadium Corporation of America, and the Welsbach Company, and the necessary tests, other than endurance tests, were made.

Endurance tests are time-consuming, and, save for a short period when the machines were out of commission due to a fire which damaged the laboratory of Sibley College, Cornell University, in which the endurance machines used in this work are located, two endurance machines have been run night and day throughout the present year. These machines will continue to run continuously for a few months longer to complete the programme.

Cerium offers no promise of usefulness as an alloying element in steel. Its use tends toward the presence of non-metallic inclusions and toward troubles consequent upon this defect.—"Iron Age."

Molybdenum Steel.

That molybdenum is one of the most powerful and useful alloying elements in steel has been conclusively demonstrated by experiments conducted by Dr. H. W. Gillett, chief alloy chemist, Department of the Interior, at the Ithaca, N.Y., field office of the Bureau of Mines. While the value of molybdenum as a steel alloy is only beginning to be appreciated and its commercial use is still relatively small, the Bureau of Mines considers that it is destined to become widely used as it deserves to be. The United States has abundant supplies of molybdenum which should be available to replace or supplement other metals used as steel alloying elements which at present must be imported.

The early claims for molybdenum as a specific against fatigue failure of steel, which alleged, directly or by inference, that molybdenum steels were vastly superior to other steels for uses to resist vibration, have not been substantiated in the over-enthusiastic form in which they were made. The Bureau of Mines' experiments show that, with one exception, molybdenum steels, and other alloy steels containing nickel, chromium, vanadium, or a combination of these elements, have equal qualities of endurance, and that no one alloy steel stands out above the others on this score.

The exception is in favour of heat-treated molybdenum steels, for the presence of molybdenum makes the steel require a higher temperature in the drawing or tempering process after quenching, and this higher temperature causes fuller release of quenching stresses. The presence of quenching stresses tends to cause poorer performance under repeated vibration. This, however, is not a very great factor, and has a noticeable effect only in very hard steels, for example, those of spring temper. For ordinary structural uses, no alloy steel is appreciably superior for use against vibration to any other when the steels are used in such sizes that they harden throughout on quenching. Molybdenum and certain combinations of nickel and chromium confer depth-hardening properties on steel, and hence these have advantages for use in parts of large cross-section.

Thus it is evident that, as regards endurance, molybdenum steels are the equals of any, and on some scores have slight advantages, but the advantages are slight instead of large. The choice of a composition of an alloy steel will therefore seldom depend on its fatigue properties.—"Iron Age."

Book Review.

Conferences de Chimie Minerale faites a la Sorbonne (Metaux). By Professor Marcel Guichard (3rd edition). Published by Messrs. Gautier-Villars et Cie, 55, Quai des Grands-Augustins, Paris. Price 30 francs.

This book on descriptive chemistry is used as a text-book for 2nd-year students at the Sorbonne University. The arrangement adopted is as follows:—The base metals, magnesium group, the iron group, copper, lead, platinum, gold and the metaloidal metals such as bismuth, vanadium, tin, etc. Some of the later chapters are devoted to solutions, especially with reference to alloys. Teachers in Universities and technical colleges will find much to interest them, and a perusal will enable them to compare French with British methods of teaching metallurgical chemistry.

Foundrymen and Teachers Hold Joint Meeting.—It is reported in the American technical Press that Quad City Foundrymen's Association recently inaugurated a joint meeting with all the district technical school teachers, in order to discuss with them the various aspects of the apprenticeship question. It is a lead well worth following in this country.

Continental Moulding Machine Practice.*

By A. S. Beech, M.I.Brit.F.

INTRODUCTION.

In the foundry trade in Great Britain to-day there are two permanent divisions of men, namely, the men who wish to press forward and also, unfortunately, a certain number who are always inclined to resist progress.

The purpose of this Paper is to assist those who wish to press forward by detailing the progress made in many Continental foundries in respect to pressure moulding machines, and also to endeavour to give sound reasons for changing their attitude to the other class of foundrymen.

It should be distinctly understood that this Paper is not meant to be controversial, but rather to give a brief *résumé* of the possibilities and the latest improvements and various adaptations of the pressure moulding machine.

It is only necessary to consult the Board of Trade Returns for the periods before and since the war to find that large quantities of castings in all metals were and are being imported into this country from the Continent of Europe, and this factor alone should make the British foundryman think seriously and ascertain if his methods are always the best.

It will be found from the Board of Trade Returns that in the year 1913 19,711 tons of iron and steel castings without any brass and aluminium were imported into this country from the Continent of Europe, a large number which ought obviously to have been made domestically. The year 1913 is selected because it eliminates any question of "rate of exchange."

Meeting Foreign Competition.

Another rather interesting light was thrown on to this matter by Mr. Lloyd George in the House of Commons on July 16, 1923, when he stated "The moment peace is restored in Europe and the exchanges are stabilised—it does not matter at what figure: marks may be at 1,000,000 and francs at 100 to the £—such advantages as we have enjoyed from the difficulties of our competitors will have vanished, and we shall be face to face with real rivalry and competition. France has not only rebuilt her devastated areas—she has reconstructed them. She has factories on the latest model, new docks, canals widened, and a mercantile marine increased by 1,000,000 tons.

"A new France has sprung up. She has increased enormously her capacity to produce the very goods we are selling in foreign markets.

"In Germany the same thing is happening. She has built railways and new factories and improved old ones. They are all ready for the great development when the settlement comes."

These are the words of a politician, and although not wishing to introduce politics, they have a bearing on the economical condition of the trade in which all foundrymen are interested. Foundrymen must carefully consider whether the methods which we have adopted in this country are on the same basis as those adopted on the Continent of Europe. If they are not, whether they are better or worse.

The author is of opinion that the British workman, when he is in the right state of mind and providing he is backed up by the British employer with the right plant and the right organisation, is second to none in the world, and it seems desirable to point out to some very small extent what other nations are doing, and to ascertain, if at all possible, whether the British are on the right road to meet this foreign competition, which has threatened us so badly in the past and which evidently is to become more dangerous than ever in the future.

No foundryman will deny that the most rapid and, generally speaking, the cheapest way of producing moulds is by the aid of the moulding machine, especially when the work is of a repetition nature.

On the Continent one finds the pressure machine almost exclusively in use, and it is also remarkable that the Jolt or any other type of machine, except in very rare cases, is seldom found in operation.

It may be safely estimated that 90 per cent. of the Continental foundries use the pressure machines even for their deep and large moulds, but in Great Britain one finds that whilst, since the war, we are steadily making progress and following the Continental ideas, before the war, generally speaking, the jolt and hand-rammed machines were adopted and used.

On the other hand, it is interesting to note that several large firms in Great Britain for the last 12 or 15 years, or even longer, have used pressure machines of different types, some operated by compressed air, but mainly controlled by hydraulic pressure owing to its cheapness, sweet working and large pressure that could be brought in to the mould.

For many years the textile machine makers in the North of England have used hydraulic pressure machines for their work. One such concern has for many years employed as many as 40 to 50 machines, operated by hydraulic pressure, so that it will be seen that some of our foundries have been using this method of making moulds quite successfully, but, generally speaking, no great progress was made with pressure moulding machines in Great Britain until after the war, and it is not really surprising now to find so many firms over here who are adopting Continental moulding machine practice.

American Practice.

In America the usual medium for working moulding machines is compressed air; it would appear this is due to the fact that compressed air is claimed to be an American invention, and also to the complete lack of the spirit of economy among the American people. Hence in America for deep moulds it is impossible to squeeze them owing to the fact that the amount of pressure, say as a maximum of 100 lbs. per sq. in., would not be sufficient unless the diameter of the pistons were considerably extended, which would make the machine very costly and clumsy.

It is rather surprising, therefore, to read a statement made by Mr. Wilfred Lewis, at the Franklin Institute, Philadelphia, on May 18, 1911, that "The jar ramming machine will not ram small work as quickly as a squeezer or split-pattern machine, and for such, a jarring machine for half-moulds weighing less than 1,000 lbs. is not often recommended."

On the other hand, squeeze machines can be used to very great depths if the medium employed for working is the correct one, and to be the correct one it will be easily seen that the amount of pressure given in compressed air machines is insufficient.

With hydraulic pressure one can obtain 750 lbs. per sq. in. working pressure on the accumulator, or even as high as 1,500 lbs. per sq in., or more if necessary.

Hence, when Mr. Wilfred Lewis says that the squeezing is better and quicker for small moulds the author insists that if Mr. Lewis had larger pressures available he would have been easily able to squeeze the larger moulds quicker and better than the jolted moulds, and this is exactly the point so forcibly demonstrated and practised by Continental foundries when they use almost exclusively hydraulic pressure machines.

Hydraulic Squeezing.

In addition to this, the power consumed when working hydraulic machines is almost negligible, for as many as 20 machines can be operated by a 5-h.p. hydraulic pump. In this respect no comparison with compressed-air machines is thought necessary, as it is common knowledge that they will use much more than 5 h.p. For the drawing of the pattern hydraulic machines give steady, sweet, and an even draw, and it is interesting to note that many types of jolting machines now draw

* A Paper presented to the London Branch of the I.B.F., Mr. V. C. Faulkner presiding.

the pattern on a cushion of oil, thus using hydraulic methods.

The Ideal Ramming of Sand.

Enthusiasts of jolt-ramming methods very often claim that ideal ramming is a mould rammed hard at the joint and on the pattern, and soft at the back; to which it could be replied that perhaps their opinion is influenced by the fact that the jolt-ramming machine cannot ram a mould otherwise.

It could also be said that ideal ramming gives a harder mass at the bottom of the mould and a softer one at the top, to allow the pressure of the metal to force the gases out to the atmosphere—this being an increasing force from the top to the bottom.

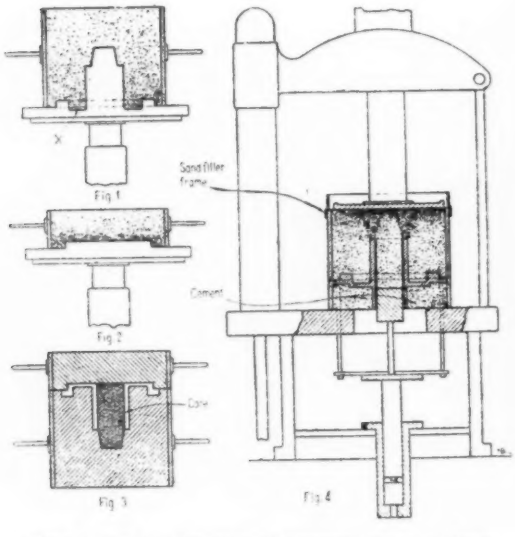
Another aspect is that ideal ramming is the one which gives a good mould without any pretence to doctrinal advice. In fact, the condition of a mould is constantly changing, according to the casting, the quality of sand at hand, and the method of working, etc. When sand is surrounded by a high part of the pattern this part of the mould has to be rammed soft, not only because the drawing from the sand is easier but also because the sand at this place has to be more permeable than when there is only metal on one side of the sand. It will be shown later that pressure ramming enables one to ram a different mould hardness in the same mould according to requirements. This is based on a method of working which is used to a certain extent on the Continent, and especially in the foundry of the author's principals, whose foundry is so well known by so many British foundrymen. This probably will be somewhat of a revelation for many foundrymen.

Taking as an example a box taking a pattern of a flat plate, which is a simple case and is very convenient for the pressure machine. However, it is often said that the mould will be rammed harder at the back than at the joint. But it is very easily proved that such is not the case. Assuming an equal thickness of sand has been put everywhere, the pressure will be exactly the same in every part of the mould except on the sides which are close to the edges of the box. This cannot be discussed, as it has been proved quite clearly by the use of a small apparatus invented by Monsieur Ronceray, based on the "Brinell" principle for testing the hardness of a mould. On the sides the friction of the sand on the box prevents the sand being rammed equally. The same thing would happen on the sides of a pattern, but this difference in ramming is not sufficiently important to prevent making a good casting, especially if the proper methods of working are used. These proper methods comprise the use of sand on the "dry" side, eventually a little hand-touching on the sharp corners, and also, if necessary, a pressure plate of a convenient shape. For instance, it is quite customary in America to have a pressure plate having a projection around so as to give a little harder pressing at the place where the friction of the moulding box prevents equal ramming. If there is a projection on the pattern nothing is more easy than to scoop out sand at this place in order to have a softer ramming at that particular point, the scoop being in proportion to the softness which is required.

Permission to reproduce Figs. 1 to 4 has been kindly given by a large English foundry. Figs. 1 to 3 are illustrations of moulds being rammed by different methods, and outline what has been said respecting ideal ramming of a mould. Fig. 1 shows a jolted half-mould, and attention is drawn to the close dots near the joint, showing how this type of machine naturally tends to make the sand hard on the face, and as the sand is followed upwards it is more and more open towards the top, which, of course, is finished off by flat ramming. This tends at this point naturally to close the density of the ramming again.

This method has been claimed by many people to be ideal ramming, because it is hard on the surface, and permits the gases to escape easily at the top; but is this, the ideal ramming in a mould, made this way?

This sounds feasible, but on examination in actual practice one finds this statement entirely wrong, because if the cope shown on Fig. 2 is correct and ideal the drag when placed in position for casting shown in Fig. 3 is exactly the reverse, and if Fig. 2 is right then Fig. 3 is obviously wrong, and certainly not ideal.



FIGS. 1 TO 4.—INDICATES RAMMING WITH A JOLT RAMMING MACHINE AND A PRESSURE MACHINE.

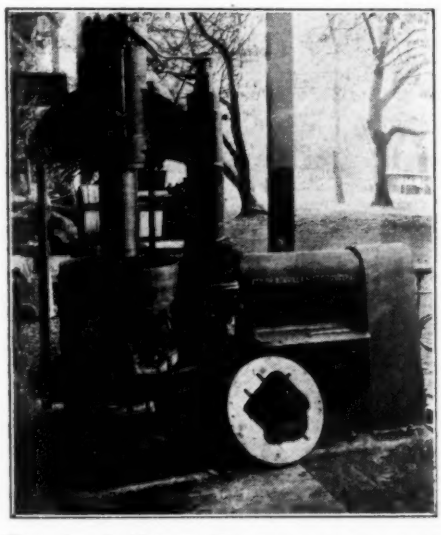


FIG. 5.—A DUMMY BLOCK IS USED WHEN SQUEEZING MOULDS WITH DEEP VERTICAL SIDES.

An examination of Fig. 4 shows the same casting being moulded on a hydraulic pressure machine. In this exactly the opposite effect is noted, but the sand can be easily scooped out or piled up in the position where softer or harder ramming is desired by the operator.

When the pattern has deep vertical sides the squeezing can be made in two successive operations, or even more, by the use of the dummy block shown in Fig. 5, which is just a rough outline in wood of the pattern.

The moulding box is filled just above the pattern, the dummy placed in position, the pressure is then applied, the ram is lifted, the dummy block is extracted, and the box is again filled to the top of the filler frame and squeezed a second time, thus getting uniform ramming all over the mould. This method, of course, is only necessary for deep moulds.

On the other hand it is often necessary to get a green-sand core such as the one shown in Fig. 6, softer than the face of the mould, and this can easily be accomplished by taking out sand from

the sand frame before applying the pressure, as explained previously.

Down-Sand Frames.

This calls for a reference to an innovation scarcely known at all in Great Britain, being only used successfully in this country by one large company as far as the author is aware, namely, the application of what is known in French as "Rehausse Inferieure," or in English as "Down-Sand Frame."

Fig. 7 shows a hydraulic pressure machine fitted with the down-sand frame. It will be seen from the illustration that the down-sand frame is supported on two small hydraulic cylinders or springs and that it is slightly higher than the joint line of the pattern plate, the actual distance between the pattern plate and the top of the down-sand frame is arranged, or decided, according to the amount of sand necessary to secure the correct intensity of ramming in the mould. When the actual distance has been determined, the down-sand frame is fixed firmly and finally in the desired position, and the moulds will all be rammed by the ramming plate going down to the same level. With this application it is possible to arrange that the sand will be rammed as hard on the side of the moulding box as in the centre of the mould. This method helps in this case towards making this place harder; because the sides of this box can be sloped and made to such a shape that when the

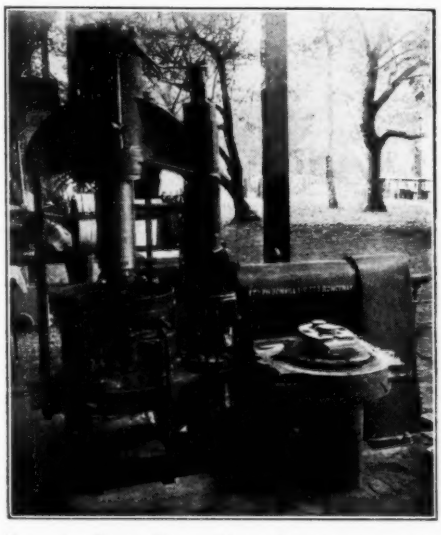


FIG. 6.—THIS GREEN SAND CORE, WHICH HAS TO BE SOFTER THAN THE FACE OF THE MOULD, IS RENDERED SO BY SCOOPING SAND FROM THE SAND FRAME BEFORE SQUEEZING.

box is being rammed it gives lateral pressure on the sides of the pattern. The ramming under the bars, which usually are liable to give a soft spot, is ideal, as the box and the bars being pressed down in the sand the bars themselves make the ramming under them. It is often the case that a bar of special shape can be made to ram sand into part of the pattern if necessary. The difficulty of ramming a barred box is done away with, as will be seen from Fig. 8, which shows the mould under pressure. It will be noted that the box-pins are not on the pattern plate but on the down-sand frame, that the pressure plate instead of going into the moulding box, as is usually the case with the pressure machine, comes on the outside of the box.

The box is filled with sand, the pressure is applied which brings down the main ram, which presses the box, resting on the down-sand frame, and also the down-sand frame to the joint line, naturally overcoming the pressure exerted by the two smaller hydraulic pistons or springs supporting the down-sand frame.

The ramming here is worthy of note. In the case illustrated in Fig. 8 the sides of the box slope upwards, so that one gets ramming on the face, ramming on the sides, and also ramming at the back. This method, however, is often applied with boxes with vertical sides.

Fig. 9 shows the pattern drawn after the mould has been taken away. It is evident that immediately the top pressure ram is placed at exhaust and starts to recede from the top of the moulding box, the two small hydraulic cylinders or springs supporting the down-sand frame and incidentally the moulding box come into operation, and start to raise the down-sand frame and the mould away from the pattern, and the mould can then be lifted away.

Scope of the Down-Sand Frame.

The down-sand frame method indicates a great stride in the process of pressure moulding machines and is particularly adaptable to repetition castings of a thin and intricate nature. One foundry using this method recently stated that their castings made with the down-sand frame can all be relied upon to pass a gauge or jig test in the unmachined state, and they definitely ascribe this to the uniform degree of ramming and hardness or softness of the mould obtained by this method.

Moreover, the output of the machine is speeded up, because the separate action of drawing the pattern is eliminated, this pattern drawing having been accomplished on the exhaust stroke of the pressure piston, by the action of the smaller pistons underneath, as has already been described, the actual ramming and pattern-drawing only occupying a few seconds. The casting shown on the

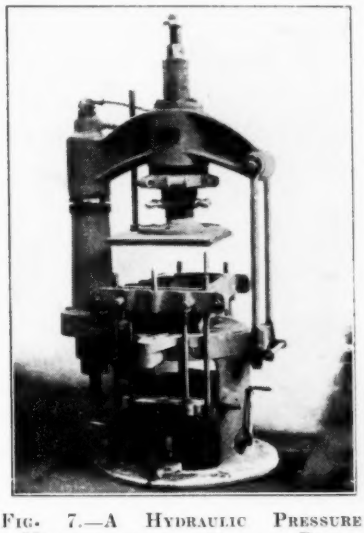


FIG. 7.—A HYDRAULIC PRESSURE MACHINE FITTED WITH A DOWN-SAND FRAME.

machine is a pot or casserole casting with very thin and essential evenness of walls. The internal core is left in the mould, and this naturally is made on the drag side of the mould with a roll-over machine.

Casserole Making.

The speed of producing this mould is very interesting. Two men with two machines produce a complete mould and close it ready for pouring every 1½ minutes. It should be understood that the down-sand frame is not to be used in every case. The squeezing of moulds with the usual top frame gives perfect castings, and is to be used in most cases where work is to be changed regularly, as is usually the custom in Europe, where large repetition quantities of castings are not the rule. On the other hand, however, the down-sand frame is to be recommended when a large quantity of castings of the same kind are required, for instance where barred moulding boxes of large sizes are required to be used, such as for large stove work. The cost of equipping the down-sand frame is only justified in such cases, whilst in the ordinary work it may be more advantageous to use the ordinary methods.

Auxiliary Equipment.

It is now believed by the company with whom the author is associated that they have nearly, if not quite, arrived at the time where there is nothing more to be done in saving time in actual moulding. The actual moulding time and pattern drawing time is now infinitesimal on a pressure machine. All that remains to be done now is to adopt better methods for bringing sand to the machines, and in the cases of large machines making arrangements for carrying boxes to and from the machines as quickly as possible.

The method of bringing sand in a satisfactory manner to the machines has generally been entirely misunderstood, and it is pleasing to note this has been dealt with in a most interesting Paper presented by Mr. H. M. Lane, of Detroit-Michigan, U.S.A., on the "Mechanical Handling and Preparation of Sands," at the recent International Foundry Congress held in Paris. The author has known a considerable number of conveyors of the chain-bucket, screw, suction or belt types and many others abandoned in this country, and he believes it is interesting to find that Mr. Lane's and Monsieur Ronceray's ideas on this subject coincide, that is, that the simplest devices are the best, and also that the sand ready for use is not to be transported in thin streams, but preferably in buckets handled by any means of conveyor, narrow gauge trucks, overhead cranes, mono-rails and so on. The pan conveyor used by Mr. Lane for filling a bucket from a sand bin is a simple and efficient apparatus, and is "the part of the chain" which was missing to make a complete system between the sand mixing machinery and the transport buckets.

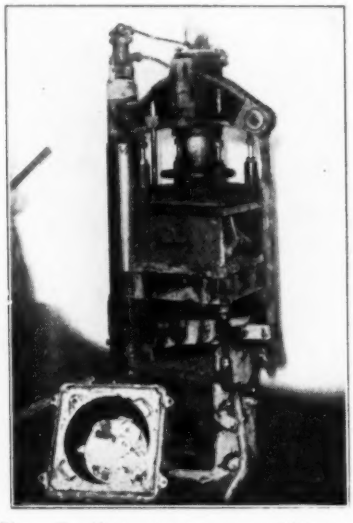


FIG. 8.—ILLUSTRATING THE METHOD USED FOR RAMMING A BARRED BOX.

The only foundry in Great Britain having a perfectly satisfactory sand handling plant, of which the author is cognisant, is that belonging to Messrs. Pease & Partners, Limited, of Middlesbrough. This is illustrated in Fig. 10. It is interesting to note that the principle agrees almost exactly with those enunciated by Mr. Lane, Monsieur Ronceray, and several other well-known Continental founders.

The author therefore suggests that it is an extraordinary coincidence that one of the best-known foundry experts of America, who has designed and put into working order many plants, such as the Buick Foundries, and who is at present engaged in the designing and starting up of the Citroen foundries in France; Monsieur Ronceray who has rapidly become one of the best known foundry experts in Europe, and in addition Messrs. Wilson & Pennington, the foundry controllers to Messrs. Pease & Partners, Limited. These are three authorities all agreeing that the simple process of carrying the sand with an overhead crane, and tipping bucket, is without doubt the best means in the long run. Moreover, these experts, being of three different nationalities, have had occasion to study this question from domestic conditions, and it would seem that their views apparently are shared universally. It is, however, suggested that it is extremely flattering to an engineer to see sand and other materials handled quickly and expeditiously by mechanical methods, but experienced foundrymen will agree that mechanical methods of handling sand have been proved in the past to be disastrous, not only because the sand gets into the working parts of the appliances, and mixes with the grease or oil, and produces an overwhelming amount of wear in a very short time, but also up to the present mechanical methods which have been devised have been confined to the carrying of sand in small quantities which has undoubtedly a detrimental effect on the sands before they reach their definite destination.

The method at Middlesbrough utilises a mono-rail leading from the sand plant to the cylindrical arrangement placed between the two machines. The exits from this cylindrical arrangement are about knee level, and it is obvious that it is very simple for the men operating the machines to get the sand into the moulding boxes with a minimum of effort and without bending the back.

This scheme particularly appeals, because sand plays havoc with any working or moving parts, and in this particular case, the sand has no chance to get near any working part, and it must be accepted that as this scheme has now been working for very many years in the foundries of Messrs. Pease & Partners, Limited, without mishap or breakdowns, it is to be greatly recommended to practical foundrymen who recognise the dangers of sand.

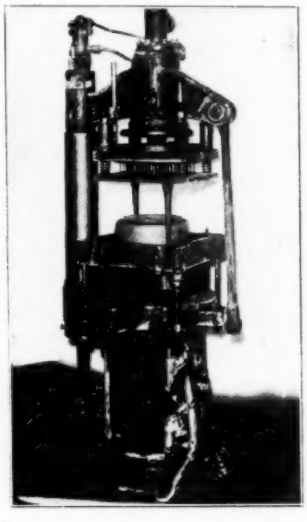


FIG. 9. — MAKING CASSEROLE CASTINGS ON A HYDRAULIC MOULDING MACHINE FITTED WITH A DOWN SAND FRAME.

The question of bringing moulding boxes to and from the machines is, of course, a question for the management of the foundry, and depending naturally on the size and description of the work to be made, but runways and cranes or other suitable plant can be installed for this purpose naturally depending on the work to be made.

Reduction of Coremaking.

Another saving, by the use of pressure machines, that might be of interest, is the fact that in very many cases vertical and even horizontal cores can be left in green sand in the mould.

Fig. 6 shows a portion of the mould for the differential gear case for the automobile from the pattern of the Société Fabrique National d'Armes de Guerre, of Herstal, Liège, Belgium, and it is interesting to note that the overhanging bosses on this mould are all rammed on the machine, without any dry sand cores, and are without any soft spots underneath, as would be the case with a jolting machine. In fact, it may be said that this job could not be made on a jar ram machine, whereas

it is quite a simple matter on the pressure machine, despite the fact that it is quite deep work, which many people state is not suitable for squeeze type of machines.

Referring to Fig. 4, shows a vertical core left in green sand in the mould on the pressure machine, but which is absolutely necessary to put dry sand in the case of the jolted mould.

This particular casting is one made regularly by a large foundry in this country, and this core is absolutely vertical, no taper being given, yet the pressure machine draws this invariably, without breaking with the aid of the lifting stool shown supporting the internal core.

The main reason for pointing out that these methods of leaving cores in green sand is to show not only a great saving in core-making, but perhaps what is more important still the reduction in fettling costs, because as everybody knows dry-sand cores inserted in a green-sand mould always leave fins at the core print.

Pattern Plates.

In many foundries in Great Britain, one still finds the old-fashioned methods of pattern-plate making prevailing, namely, a cast-iron plate machined accurately on both sides, and carefully marked off for locating the pattern and the moulding box pins, after which several trial castings have to be made to ascertain whether the marking off of the pin centres is in correct relation to the pattern.

FIG. 10.—HOW SAND IS HANDLED AT THE WORKS OF MESSRS. PEASE & PARTNERS, LIMITED, MIDDLESBROUGH.

Further, it is usually necessary when a metal pattern is required, to make this in brass or iron which, of course, is very expensive to finish off. The methods used for making pattern-plates for the hydraulic machines are extremely efficient, and at the same time very cheap. The making of a white metal match plate, for the machines which ram the cope and the drag in the one operation, is simply made by preparing a good mould of the patterns, placing a rough cast-iron frame in between the two boxes, and pouring white metal into the dovetails provided in the cast-iron frame.

On the other hand, however, for split patterns it is customary to use very cheap, but very accurate pattern-plates made in metal without any machining and practically no finishing, and backed up at the back with cement. These plates can be made with or without stripping plates, entirely by a moulder, without any machining, simply being rubbed over with sandpaper after casting. It is backed up at the back in the frame shown with cement, and the stripping plate can be made to follow the joint line, that is up or down as required.

The stripping plate is made by the moulder, at the same time as the pattern, and as it is made from white metal, it can be melted down again when it is finished with, thus the cost is simply moulders' wages, the material never being lost.

These pattern plates are capable of giving at least thirty to forty thousand castings before the pattern-plates need to be re-touched.

Fig. 11 shows a very complicated pattern-plate using internal and external stripping plates, the cost of which was £5. To have made a machined plate and stripping plate, would have cost a large sum of money.

This opens naturally a new field of activity for the moulding machine, because it is obvious that if the initial cost of the pattern-plates is low, it is possible to put castings on the machine for even smaller quantities which hitherto would have been considered unprofitable for putting upon machines, owing to the high initial cost of the pattern-plates.

Moulding Sands.

One hears from many sources in this country that moulding sands are better on the Continent of Europe than in Great Britain, and this is often used as an excuse by foundrymen in this country when the clean Continental casting is brought up for discussion.

The objections usually associated with squeezer machines are often due to ignorance as to the best means of carrying out the operations.

It is quite common to find a foundryman un-

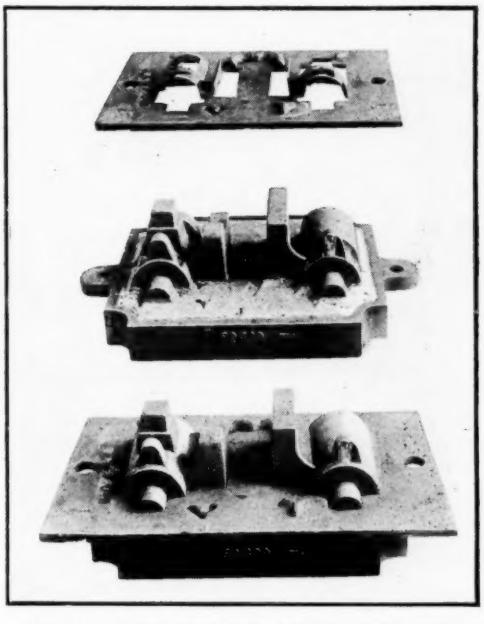


FIG. 11.—SHOWS A SPLIT PATTERN PLATE AND STRIPPING PLATE MADE WITHOUT ANY MACHINING.

acquainted with the type of moulding machine offered to him endeavour to extract from the maker of the machine an undertaking to produce moulds by employing the same sand, and also the same method of working, as he himself has followed in hand-moulding. Without wishing to cast any slur on the foundrymen who go in for any type of machine moulding, it is not an exaggeration to say that any competence that they might possess in hand moulding can scarcely help them in their desire to get the best results from machine moulding. If one studies this point carefully, one can quite see that it is correct.

Little by little machine-moulding methods have progressed, and are distinctly removed from the accepted theories prevailing in this country with regard to hand moulding. In fact, the difference is so great that it sometimes confuses even the most open-minded persons.

On the other hand, it is a fact that machine moulding has, without doubt, thrown much light upon hand moulding, and the conclusions to be drawn are far too precious not to be profited by when moulding by hand.

The author refers principally above to the use of dry sand, and it would be perfectly obvious to all here present if an illustration of what is meant is given. For instance, on account of the incompetence of the men operating moulding machines

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on the Continent they are never permitted to patch a mould or use a tool. The pattern-plate and stripping-plate, where a stripping-plate is necessary, must be perfect, and the pattern drawing so accurate that a perfect mould is obtained without any patching or touching up.

Such a state of affairs permits, in conjunction with a pressure machine, the use of a much dryer sand, the dampness for patching by hand being no longer necessary.

The advantages to be gained by the use of dry sand will be manifest, and such a state of affairs has permitted the production of a sand on the Continent sufficiently dry to flow in a much better manner round the pattern under pressure.

It is obvious, therefore, that the sand being drier and flowing round the pattern, has many advantages, and perhaps accounts to a great extent for the excellence of skin and finish on the castings produced on the Continent.

The dry sand rams much better under pressure, consequently it is no longer necessary for a press head close to the restricted or deep parts, but simply a finger touch, before the press ramming.

It does not scab, mainly because, being drier, much less steam is generated in the mould, and it

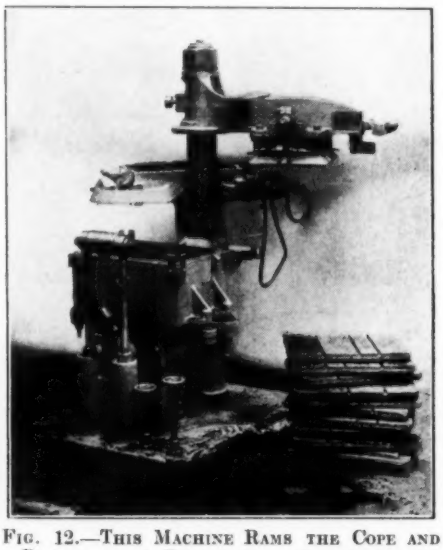

FIG. 12.—THIS MACHINE RAMS THE COPE AND DRAG IN ONE OPERATION, WITHDRAWS THE PATTERN PLATE, CLOSES THE MOULD, AND PUSHES THE MOULD COMPLETELY THROUGH THE BOX.

remains permeable; thus venting the mould is not necessary in most cases.

The conclusions drawn are that this interesting use of drier sand, whilst ideal for the pressure machine, can also be of inestimable value to the hand moulder.

For instance, at one foundry in France the author saw hand moulding being done with green sand with practically the same dry sand used for the pressure moulding machines, and with little or no peg ramming, but merely hand tucking and butt ramming.

If any sand was broken in extracting the pattern it was only moistened where broken, but only to the least possible extent.

All these points have struck the author most forcibly. When studied, they seem very simple, but they are basically the outcome of sound common sense and careful thinking.

To the author's mind there are many excellent sands in this country, and the old idea of the superior sands prevailing on the Continent can be ruled out.

Several foundries in this country are producing excellent results from the proper preparation of moulding sands and in following the ideas of Continental foundries.

A Special French Pressure Machine.

The machine illustrated in Fig. 12 is used for the rapid production and for shallow castings. It is well known in Great Britain, but for the benefit of those who are not familiar with it, it should be pointed out that it rams the cope and drag in the one operation, withdraws the pattern-plate, closes the mould, and pushes the mould completely through the box.

The speed of this machine is very great, and with moulds containing one core only the author has seen 350 moulds put down by two men in eight hours, and this has been accomplished day after day.

In the North of France, at Turcoing, a foundry there produces regularly 400 moulds per day of eight hours, without cores, with two men.

The conclusions the author has drawn from his experience on the Continent and in this country resolve themselves into the following, and will probably act more or less as a guide to foundrymen who contemplate installation of machines or use of their existing plant:—

Conclusions.

(i) For all moulds, small or medium, relatively shallow, squeezing should be selected.

(ii) For all moulds, small or large, low or deep, where the pattern drawing is most important and wherever projections or loose pieces are to be used, pressure ramming is advisable, even when it involves ramming by two or more squeezings.

(iii) For large, flat moulds, jolt-ramming presents many difficulties, but, however, it is specially convenient when there are a large number of narrow pockets of sand, such as a Continental radiator tube.

(iv) For large moulds of deep and simple castings, where the pattern drawing is of secondary consideration or where there are only a few moulds required off a pattern, the jolting machine is to be recommended. The finishing or patching to be done by hand.

(v) Water pressure is desirable in all cases for pressure machines, for the reasons stated previously, as it alone permits the pressure of large moulds.

It will thus be seen that in the author's opinion that where hydraulic pressure is used the pressure machine exhibits distinct superiority, and it is hoped that the views placed before you showing what is being done on the Continent in this direction, will be of interest to the foundry trade in this country.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

The Decline of Semi-Steel?

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—On several occasions recently I have found foundrymen asking me whether this or that concern is still using semi-steel mixtures, or have they, too, changed over to the use of special low-carbon pig-iron? After hearing this several times, I inquired of several merchants supplying special pig-iron whether they were experiencing increased sales. The result of these conversations seemed to add weight to the supposition that semi-steel is losing ground. Obviously, it is not a question of direct economy. What factor is operating to bring about these conditions? Is it just a passing fancy or are foundrymen experiencing a difficulty in obtaining just the type and size of steel scrap they deem necessary? Surely semi-steel has sufficiently established itself as a reliable, easily made material. The writer fails to realise why equally good results should not be obtained with steel mixtures as with low-carbon pig-iron, excluding the possibilities of inherent properties, body or whatever it may be termed. Yet there appears to be turnover from the former to the latter, and this, too, by foundry managers of established reputation. It would be interesting to have my observation confirmed or refuted, as it may be just a coincidence.—Yours, etc.,

"CUPOLA."

[We, too, have noticed a similar tendency, though by no means general. We do not attach any importance to the suggested shortage of suitable steel scrap, but would prefer to look to the increased reliability of special pig-irons now on the market, due perhaps to the scarcity of business allowing the manufacturers to effect better grading and so enhancing the reputation of the material. —EDITOR.]

An Apprenticeship Course in Foundry Practice.—LXV.

By Ben Shaw and James Edgar.

THE PREPARATION OF MOULDS FOR BRASS AND BRONZE.

Brass moulding practice is not fundamentally different from that of iron and steel. The moulds may be made in green sand, dry sand or loam, and the methods adopted in preparing them include both the turnover and bedding-in processes for sand moulds, and, when the material used is loam, strickling, sweeping and building with bricks cover the general methods as for iron and steel. To secure a good skin on non-ferrous castings and to facilitate cleaning, it is customary to use some special facing, either by dusting over the mould, as in green-sand work, or applied in the form of a wash as in dry sand or loam work, and the same care is necessary as for moulds that are to receive cast iron or steel. Moreover, brasses and bronzes are hot short and contract considerably—the amount varying slightly with the composition of the brass or bronze—when cooling to a normal temperature, and they are therefore liable to rupture or to become strained unless the mould is formed so that little resistance is offered to contraction, and, as with other metals and alloys, there is the same need for a uniform thickness of metal in the design of the castings required, or at least graduating the various thicknesses, so that abrupt changes are minimised in order to reduce local strain. In a general sense, therefore, the principles of moulding that have been considered in previous articles in this series, are applicable for brasses and bronzes, but modifications in practice are necessary to cope with the special characteristics of the varying compositions of non-ferrous alloys, and incidentally other materials are involved that are not associated with the making of moulds for either cast iron or steel. It is the purpose of this article to consider the preparation of moulds for brass and bronze in a comparative sense, and to endeavour to describe the essential differences in practice from those necessary for iron or steel.

General Differences.

In the brass foundry, moulds are more generally made in boxes, comparatively little work being done in the foundry floor, and bench moulding is more customary than in either the iron or steel foundry. This is due largely to the fact that a greater percentage of small castings are made in the brass foundry and those that would be classified as large castings compare in size with what is more generally referred to as medium-sized work in the iron or steel foundry. Non-ferrous metals are expensive, and are not used for large work unless the special qualities they possess make it desirable to satisfy special conditions of service. The natural tendency is to use a relatively cheaper metal, such as iron or steel, providing the metal fulfils the conditions that are required. Dry-sand moulds are used for small castings that would be made in green sand in the iron foundry or even in the steel foundry. This does not mean that green-sand work is excluded, but that in practice it has greater limitations than in the iron foundry. This difference in practice is more noticeable when the moulds are for the various bronzes, particularly the phosphor bronzes and those usually termed gun-metals. There are several reasons for dry-sand moulds being preferred. Phosphor bronze, for instance, is an extremely active alloy and very searching in its character, and if poured into a green-sand mould, it is important that the metal should have the proper pouring temperature. This necessitates constant observation until the change of surface shows the proper time for pouring or the correct temperature is determined by some form of pyrometer. Castings that are poured when the pouring temperature is too high will, whether large or small, be so rough if made in green sand, that in many cases they are useless. When there is some difficulty in determining the proper pouring temperature, it is advisable that the moulds be made in dry sand when the surfaces can be given a special facing wash which is more effective in limiting the searching character of the alloy and allows for slight excess in pouring temperature. All bronzes, however, tend to eat into the sand considerably, and are likely to cut green-sand moulds and cause a fair amount of scabbing, unless an effective facing is used or the moulds are skin dried. It is mainly because of this fact that moulds for other than small bronze castings are generally made in dry sand. Modifications are also necessary with regard to the running of castings in non-ferrous alloys. Many alloys, particularly the brasses, readily chill and solidify, and have not that fluidity associated with cast iron, and it is therefore necessary to increase the area of entry to the mould otherwise the metal may not fill it, or even if it does so may cause parts to become so cold that they may fail to unite.

Green Sand Moulds.

The practice is very common to prepare green-sand moulds on a bench over a trough containing the green sand mixture. This is particularly so in the smaller brass foundries in which the floor is used for dry-sand work and is made up of suitable sand for the purpose. The suitability of green-sand moulds for these alloys depends largely upon the size and character of the castings to be made. The sand needs to be graded to suit the general run of work, and if a fine grained sand is used for small castings in order to obtain a good, clean definition the same sand mixture, if used for larger work, is likely to scab, as it is more readily cut by the wash of the metal. This is likely to occur even when a special facing has been applied, though a skin-dried faced mould will minimise the effect. The quality and condition of the sand used is an important factor, but the grading of its fineness should not be overlooked. Sand of a similar refractoriness to that used for cast iron is satisfactory except for those alloys that contain nickel when it should be low in fusible impurities. The pouring temperature of the various alloys used in the brass foundry are generally lower than for cast iron, and sands that can be used for iron are also used for brass and bronze. Mansfield and Birmingham sands are representative of the red sands of central England that are suitable for both green- and dry-sand work. Erith sand is also used to a considerable extent, and is effective. The mixtures of course vary in strength and size of grain to suit the work, special facing mixtures being rarely used for small work, but for larger work that may be made in green sand, more especially when the castings are to be of some bronze composition, coal dust may be added to form a special facing, as in the case of similar moulds for cast iron. The moulds generally require to be rammed to a greater density than for cast iron, more particularly at the face to obtain a good surface on the casting. Venting is just as necessary as for cast iron, and there is greater need for needle vents and risers because as the metal solidifies readily, the back pressure of gases which would cause a waster with brass is not so likely to do so with cast iron, as the latter retains its fluidity longer, and often adjusts itself when the pressure is released. When special facings are used—they are not always necessary—one of the best that can be used for brass castings is ordinary flour. This is far superior to graphite, as a good colour is desirable on the castings as well as a smooth skin. It can be dusted and the mould subsequently sleeked, but it is equally as effective to dust the mould and brush it lightly with a camel hair brush, blowing out any surplus. For the bronzes either graphite or French chalk are suitable. The former gives the casting a dirty appearance, but a smooth skin, and the sand leaves it readily. Both, however, are easily sleeked, and provide a smooth surface on the mould which reduces the possibility of the metal

cutting the sand and consequently scabbing the castings.

Dry-Sand Castings.

The practice prevailing is somewhat similar to that for cast iron, but since the moulds are, as a rule, made in boxes they are dried in ovens rather than by means of braziers or other special mould-drying apparatus. The moulds being small, comparatively, they are easily transported to ovens. A good practice, and one which is much favoured to facilitate drying, is to use a framed bogie, formed from I-section wrought iron, upon which the moulds are laid. By this means the heat is circulated, and is more effective for drying the moulds. As it is desirable to cast many jobs on end, especially when of bronze, in order to use a feeder head or to make more effective use of risers, boxes offer a special advantage in that moulds in them can be prepared horizontally and turned into any suitable position for casting, as in the case of high-pressure valves. Dry-sand moulds are invariably given a facing wash when green and dried subsequently. A very satisfactory wash for this purpose, especially for phosphoric bronzes, is composed of graphite bonded with china clay. In some cases a thin solution of china clay only is used. Flour, too, enters into facing solutions either as a bond or alone, but only for the smaller work, and usually for brass. Chills are used in moulds for the alloys of copper to an extent comparable with those for steel castings. They are used for a similar reason—that of securing, as far as possible, uniformity in the rate of cooling. When metal chills form a considerable part of a mould, water is sometimes circulated in the chill to absorb the heat from it. These are, however, confined to special work when many similar castings are required, because this form of chill is expensive.

Loam Moulds.

Much less loam work is, as a rule, prepared in the brass foundry than in the iron foundry. This is largely due to the fact that work being on the whole smaller, the percentage of full patterns and coreboxes is correspondingly greater, and dry-sand moulds are, as a rule, more readily prepared when full patterns are supplied. Furthermore, the type of castings that is made in brass or bronze differs from that in the iron foundry, as, with the exception of bushes of varying sizes, there are few cylindrical castings for which a loam mould would be more effectively swept up or for which a loam pattern can be made. Even with bushes and liners a dry-sand mould is more generally prepared because it is customary to stock standard patterns, which can be easily modified to suit a particular job when many castings of this type are called for. Loam is, however, used for making moulds of large size or of exceptional character, such as manganese brass (manganese bronze) propellers or for work of a jobbing character, when the moulds can either be partially or wholly swept by means of a profiled edged board or when a skeleton pattern will fulfil requirements. It is mainly for cores that loam fills a special need in the brass foundry, and more generally for cylindrical cores that are swept on a horizontal spindle. Comparatively little loam work is prepared about a vertical spindle. Although the preparation of a loam mould in the brass foundry varies but little from that in the iron foundry, a tundish is more frequently used for running and feeding the job at the time of casting. This consists of a receptacle almost large enough to accommodate all the metal necessary for the casting. It is not until the tundish is filled and the metal is at the right temperature that it is allowed to enter the mould. The method of control resembles the stopper arrangement used in ladles for steel. The use of a tundish is advantageous for large work, forming a receiver in which the metal can be poured from more than one crucible or ladle, ensuring a better mixture and incidentally allowing occluded gases to rise to a certain extent.

Pouring Temperature.

The temperature at which the various alloys are poured has an important bearing upon the quality of the resultant castings. The strength of the casting is largely affected by variations in the rate of cooling, as this affects the structure of the metal. When the metal is "hot" rather than "dull" the slower cooling gives the crystals a better opportunity to grow, and, providing the temperature is not too high, a stronger structure is formed. On the other hand, with the temperature too high gases are more likely to be retained in the metal and minute blowholes will be formed which break up the metal structure and reduce its strength. It is more profitable to make use of a pyrometer to determine the temperature of the metal so that it may be poured at the temperature most suitable for the alloy being used and the design of the casting being made. The temperature of the metal is, of course, not always responsible for producing blowholes or porous castings which is a very troublesome feature with some bronzes, particularly that known as Admiralty gunmetal. There is a variety of causes of blowholes. They may be the result of dampness in a dry-sand mould or a too-damp green-sand mould, gases may be trapped in the mould, or they may be the result of the reduction of metallic oxides that have been formed and are mechanically mixed with the metal. It is, however, one of the chief factors in obtaining sound castings, and the margin between, which is the most desirable temperature, is with many alloys so small that a pyrometric reading provides the best safeguard against loss from this cause. In the case of Admiralty gunmetal previously referred to, Dr. Carpenter recommends a casting temperature between 1,120 and 1,270 deg. C. Outside these extremes the effect on the strength of the metal is very pronounced. This, however, is only one composition, and since the suitable pouring temperature varies with the composition, it is obvious that it is difficult to judge the temperature with a reasonable degree of accuracy without some form of pyrometer, and that which is generally preferred is the thermo-electric pyrometer. This instrument consists of two parts, the thermo-couple and the indicator or galvanometer. It is based on the principle that by heating the junction point of two dissimilar metals an electric current is generated. The junction is formed by welding the two wires together, one of which is usually platinum and the other an alloy of platinum and 10 per cent. iridium or rhodium, though not always, and these are encased in a protective sheath or tube. This tube is fitted to what is known as the cold junction box, in which the wires are connected to terminals from which a connection is made to the galvanometer. When this instrument is used it is inserted into the metal, and as it becomes heated a needle moves along the chart in the indicator and registers the temperature.

High Silicon Pig-Iron.

During the discussion of an address on "The Blast Furnace in Relation to the Cupola," by E. J. Lowry, metallurgist, Hickman-Williams & Company, Chicago, before the Detroit Foundrymen's Association, a speaker argued that it was better to use silvery iron in the lower silicon contents, 5 to 8 per cent., than to use the higher silicon contents, 12 to 14 per cent. Illustrations were given to carry this point, and it was generally agreed that such was the case.

Following the lecture, discussions on the subject and on American foundry practice were entered into by the members and the speaker. The question of the control of carbon in the cupola was brought out by the speaker and debated. It was finally concluded that the height of the coke bed in the cupola influenced the carbon pick-up and the iron. It was also shown that uniformity in the casting work in a foundry was more easily attainable by the use of a charge which equalled the "tap."—"Iron Age" report.

MELDRUMS, LIMITED, of Timperley, nr. Manchester, received orders during October for forced draught furnaces for 16 boilers, and stokers for 5 boilers, 7 destructors and a disinfector, and a gas washer-scrubber to deal with 22 million cu. ft. of gas per 24 hours.

Brass Foundry Work.

At a meeting of the North-East Coast Local Section of the Institute of Metals held on Tuesday, November 13, Dr. Percy Longmuir gave a lecture on "General Scientific Brass Foundry Work," Mr. S. G. Homfray acting as chairman.

In opening his lecture, DR. LONGMUIR said hot pressing and extrusion processes that were competing with the foundries very very severely, possibly was a result of the great amount of research work that had been done. The brass foundry, however, had spent nothing in this direction, but ought to take it up actively in the future if progress was to be made. The present depression in trade presented great opportunities for investigating difficulties with the requisite leisure. It was necessary that the scientist should work in co-operation with those who have an intimate knowledge of the preparation and making of the mould.

Of the scientific side of the question, the first and foremost foundation is that of chemical analysis. He had known so-called ingot copper to contain as much as 2 per cent. of zinc and then the cost of an analysis was nothing because the 2 per cent. of material would be invoiced at a price distinctly higher than that of the analysis. No foundryman, nor his scientific advisers, liked the indiscriminate purchase of scrap. Scrap generally failed on test for the reason that when it was bought in large quantities it might be Admiralty gunmetal or anything else, and it was almost impossible to sample it so as to get a representative analysis of the bulk. In engineering works, which work on their own materials and exclude the outside purchase of scrap, it has been found profitable, in many cases, to have the machine cleanly swept down before another alloy was used. For instance, if the machine had been running on condenser metal and was next going on to Admiralty gunmetal, all the condenser metal borings were cleaned off before putting on the Admiralty gunmetal. In other cases, where complete separation is not possible, it is advisable to melt the whole in an air furnace, to analyse and to use accordingly.

Another point of chemical analyses is that the time has arrived for maintaining certain standard compositions, and especially so with so-called high tension brasses, when it is of vital importance that the copper and zinc contents are kept in the neighbourhood of 60 and 40 respectively.

He would like to emphasise that if further progress was to be made in foundry practice, studies of the liquid metals were essential. He would not like to say that those studies would get over all the trouble, but they would certainly go a long way to helping the foundry to solve its difficulties.

Still keeping to liquid metal, he said that the study of fluidity presented another large field for research. Fluidity was not always a question of super-heat, certain metals or alloys having different running powers from others, irrespective of temperature.

Research on liquid metal and alloys would lead very far towards the obtaining of data valuable to the foundry for solving its difficulties in dealing with liquid contraction, and equally so in the studies of temperature effects.

DISCUSSION.

The CHAIRMAN (Mr. S. G. Homfray), in opening the discussion, said he thought it had been a very interesting little talk and the only thing he could say against it was that it was too moderate. With regard to what Dr. Longmuir had said about routine analysis, it was the minimum of what was really necessary nowadays.

Referring to manganese bronze, he asked the lecturer whether he had found the solid contraction of manganese bronze to differ from gunmetal, as people's opinions seemed to vary on that point.

He believed that, in the past, the practical man had been rather prejudiced against the metallurgist by the publication of researches which had been carried out on insufficient quantities of material, and which had frequently led to completely erroneous conclusions.

MR. F. ADAMS said he had noticed that the lecturer rather condemned the use of scrap in the foundry, but what were they to do without it to-day? If one buys scrap to analysis and finds that it is not what it was bought for, the thing to do is to reject it.

Dr. Longmuir had accused the brass foundry of making no progress, but was that quite true? He (Mr. Adam) thought that the brass foundry had advanced a very great deal. Only the other day he had come across a book published less than 20 years ago, which stated that there was no instrument for measuring the temperature of brass. The fact that pyrometers are regularly used in the brass foundry to-day for measuring the temperature of brass proved that there had been some advance made during the last few years.

With refernce to manganese bronze, he would like to know how, by looking at the fracture, the lecturer could tell what percentage of zinc it contained.

Also with reference to the use of different temperatures for various jobs, he would like to ask how they were going to overcome the difficulty when there was a test piece, and whether they had to have one temperature for the test piece and another for the casting.

MR. J. HAMILTON asked how the lecturer would measure the viscosities of molten alloys which had various running properties.

MR. A. BRAILSFORD said he would have liked some draughtsmen and designers to have been present. He had always experienced the greatest difficulty in getting draughtsmen and designers to realise that uneven thicknesses weaken a casting instead of strengthening it. One does not seem able to point out that it is a source of weakness and not of strength, both in cast iron and in gunmetal.

He was of much the same opinion as Mr. Adam as regards scrap. They had to use a good percentage of scrap for a casting or could not compete commercially with other people.

MR. H. M. DUNCAN (secretary) asked what fluxes the lecturer would recommend for the different metals, because he thought it was very important to have a suitable flux. Perhaps the lecturer used some special ones.

He agreed with Mr. Adam about scrap, but thought that what the lecturer had condemned was the indiscriminate use of scrap without analyses.

With regard to tests on gunmetal, he would like to know whether Dr. Longmuir did not think that one got a better test by adding a little arsenic.

MR. G. LILLIE said they had always endeavoured to work upon a scientific basis and had only had one failure in two years. He had never heard anyone advocate the use of arsenic to any extent, and, moreover, had heard metallurgists speaking against it.

Also he would like to know what Dr. Longmuir would call an over-heated metal. He (Mr. Lillie) had worked to 1,200 deg. C. and obtained good results on test bars cast on the casting.

MR. MIDDLETON, referring to Admiralty gunmetal, asked whether the lecturer would recommend annealing for a casting which had been cast too hot or too cold. He would like to know whether Dr. Longmuir advocated annealing at all, either from the mechanical or hydraulic test points of view.

MR. A. LOGAN said they put a little arsenic in their gunmetal, but he did not think that high arsenic was consistent with high tensile.

He would like to know how the lecturer would control non-ferrous metals by means of pyrometers because they were always up against that difficulty. That brought him to the question of temperatures for gunmetal, and he presumed that for any particular casting the lecturer would admit that there was a correct casting temperature.

With regard to manganese bronze fractures, he did not think that fractures were very much used now, although they were possibly found to be useful at one time when there was nothing else.

XUM

The Lecturer's Reply.

In replying to the discussion, DR. LONGMUIR said he would candidly admit that he could not answer all of the questions; in fact, he did not think that many of them were answerable.

The Chairman had raised a most vital point when he mentioned the publication of researches which were carried out on such small quantities of material as to be utterly misleading and which had caused the scientific worker to become very unpopular. He (Dr. Longmuir) had known researches to be made on weights of less than 1 lb., and, obviously, in a case like that the influence of mass was missing entirely and the results could not have any other than an academic value.

Mr. Adam, and one or two others, had not agreed with his remarks about scrap. What he had condemned was the indiscriminate use of scrap bought from scrap dealers, as nothing could vary so much as so-called gunmetal or brass scrap. If a truck load varied the chemist had not a chance, but if the scrap was from a known source it ought to be satisfactory. He hoped he had made it clear that it was the assorted and miscellaneous scrap that he had referred to.

He agreed with Mr. Brailsford that a few designers should have been there. He did not know whether it was that the drawings were easier to produce with square corners, but the designers certainly seemed very fond of them.

With regard to fluxes; generally speaking, if the metal was melted in a non-oxidising temperature the simpler the flux the better. There was no patent flux for any given metal, but he had found that charcoal was usually satisfactory. He disagreed with Mr. Duncan that arsenic gave high tensile, and did not think that it was the arsenic alone which had brought up the tensile test, and he did not know whether it was a commercial propositlon or not.

Annealing would not remedy the variations in casting temperature, and, generally speaking, he would not recommend annealing for non-ferrous metals.

The lecturer then touched upon the re-crystallisation of lead, and said it had been discovered that the lead on roofs re-crystallised in about three months. They had also proved this with some bars which had been kept for three months, and they found that re-crystallisation took place at atmospheric temperatures.

In reply to Mr. Logan, he said that the silica sheath was excellent as a pyrometer protector, but the ideal pyrometer was yet to be introduced.

With regard to manganese bronze fractures, he did not recommend that method at all, but in the olden days when laboratories were not so plentiful it was better than working in the dark.

MR. HOMFRAY said that Primrose was a great believer in the annealing of non-ferrous metals, and stated in his book that it had an extremely beneficial effect. They themselves had annealed pressure castings which had failed the hydraulic test to a slight degree and had found that certain test-bars gave distinctly better results after annealing.

DR. LONGMUIR, in reply, said he thought that most castings, with perhaps the exception of aluminium alloys, could be successfully produced without heat treatment, but, in other directions, heat-treatment was absolutely essential.

MR. DUNFORD SMITH, in proposing a vote of thanks to the lecturer, said he noticed that, in his final remarks, the lecturer had made reference to the re-crystallisation of lead, but he (Mr. Smith) did not think they could be quite sure that re-crystallisation took place in three months when one considers that the lead might probably have been at the manufacturer's or in the plumber's shop for a few months before it was put on to the roof.

He did not altogether agree with the lecturer with regard to scrap. He had just had to do with the sorting of about 20 tons of gunmetal scrap, which consisted of manganese bronze, ordinary brass, etc. By the difference in appearance and fracture they were able very successfully to sort out the material, and he thought that it was marvellous how an unskilled man could tell whether a piece of metal was gunmetal or not.

As regards copper with 2 per cent. zinc, he did not understand how one could get such a large percentage of one impurity. The brass foundry generally bought the best material, and, therefore, any one impurity should not amount to very much.

MR. ADAM seconded the vote of thanks.

After DR. LONGMUIR had suitably replied to the vote of thanks, the meeting was closed.

Gazette.

THE BOSTON ENGINEERING COMPANY, LIMITED, Wide Bargate, Boston, Lincs., are in voluntary liquidation.

A RECEIVING ORDER has been issued in the case of E. Nystrom, 3, Brookwood Avenue, Barnes, engineer. Exam., C.C., Wandsworth, December 20, at 11.

A RECEIVING ORDER has been made in connection with the affairs of Mr. H. Simpson and Mr. J. T. Simpson, trading as Thomas Simpson, 20, Orange Street, Halifax, brassfounders.

THE SHAREHOLDERS of the E. C. Lewis Foundry, Limited, have decided to wind-up the company. Mr F. Morse, 1 and 2, Great Winchester Street, London, E.C.2, has been appointed liquidator.

A RECEIVING ORDER has been made in connection with the affairs of the Tower Ship Repairing and Engineering Company (other than L. C. Forbes), an infant, 180, Tower Bridge Road, London.

THE PARTNERSHIP heretofore subsisting between Messrs. T. Burton and N. Burton, scrap metal and coal dealers, 9, Boothroyden Road, Rhodes, under the style of T. Burton & Son, has been dissolved.

THE PARTNERSHIP heretofore subsisting between Messrs. T. S. Bowman, G. Hughes and G. Hooton, engineers, iron and brass founders, 100, Irlam Road, Bootle, Liverpool, under the style of the Irlam Foundry Company, has been dissolved. Mr. T. S. Bowman continues.

NOTICE HAS BEEN FILED of the appointment of Mr. J. Davie, 3, London Wall Buildings, E.C., as receiver and manager of the Park Royal Engineering Works on behalf of the first debenture holders. The appointment of a receiver will serve to protect the company's position during the carrying through of a scheme for the reorganisation of its finances. In the meantime the business will be carried on as usual. A petition for the winding-up of the Park Royal Engineering Works, Limited, will be heard in London on November 27.

THE CREDITORS met, last week, at the London Bankruptcy Court, of Mr. F. W. Charles, iron and steel merchant, King's Chambers, Angel Street, Sheffield. The Official Receiver reported that the debtor had stated that he had failed on a previous occasion in 1906, from which proceedings he was still undischarged. Since his previous failure and up to the outbreak of war in 1914 he was engaged in selling merchandise on commission. In March, 1917, he gave up the appointment, and commenced business on his own account as an iron and steel merchant, under the name of F. Charles, which was shortly afterwards changed to Charles & Company. He carried on business successfully till 1921, when, owing to the slump, many large contracts were cancelled, and his stock had to be realised at low figures, owing to depreciation. Early in 1919 he entered into a contract to purchase gun forgings, for which he had a contract at a price of £5 16s. 6d. a ton. The Ministry failed to deliver, and late in August, 1919, he proceeded against the Crown to recover £60,000, representing loss of profit. He eventually obtained judgment for £27,800, in respect of which the Crown paid him £20,000, plus taxed costs, in settlement. His share of the £20,000 was one-fifth, and after paying the debts then existing there was not much left. His acute financial difficulties did not arise till about the middle of this year. The debtor estimates his liabilities at £5,000 and his assets at £1,262. Mr. F. S. Salaman was appointed trustee.

Aciéries de France.—This French concern is about completing its new rolling mills at Isbergues, which are to start work in the New Year.

Spanish Iron and Steel Industry.—Spanish iron and steel manufacturers are studying means by which they could offer to their Government all material for public works on the same terms as their foreign competitors.

South Russian Yugostal.—The working programme of this Mining and Metallurgical Trust (Yugostal) for 1923-1924 includes the following items of output:—Coal, 1,440,000 tons; coke, 432,000 tons; pig-iron, 288,000 tons; steel, 336,000 tons; rolled products, 304,000 tons.

The Manufacture of Ferro-Alloys.—III.

By J. A. Holden, M.I.Brit.F.

THERMIT FERRO-TUNGSTEN.

Ferro-tungsten can be prepared by the electric arc smelting of wolframite, or by a thermit reduction process. When low-carbon alloys are required the latter process is used. Commercially, the ferro-tungsten thus produced is spoken of as carbon free; actually, however, it usually holds from 0.08 to 0.20 per cent. of carbon.

Wolframite may be reduced entirely by means of powdered aluminium. This method is rather costly, and it has no advantage over the method to be described. By commencing the reaction with aluminium powder and then completing with powdered high-grade ferro-silicon it is much cheaper, the reaction is not so violent, the yield is higher, and the process is under better control. In practice it is very difficult to adjust the reaction with sufficient accuracy to ensure a satisfactory yield of tungsten and obtain freedom from aluminium and silicon in the alloy. It is therefore not surprising that thermit ferro-tungsten invariably contains aluminium and silicon. The alloy has been used for the manufacture of various kinds of tungsten steels—such as high-speed steel, high magnetic retentivity steel, etc.—both by the crucible and the electric furnace processes, with satisfactory results.

The most detrimental impurity in wolframite, from a steelmaker's point of view, is tin. Fortunately, only a fraction present in the one finds its way into the ferro-alloy. As a safeguard it is customary to specify a maximum of 0.2 per cent.

Method Used.

The ferro-silicon used contains from 88 to 95 per cent. of silicon, and the granulated aluminium should be pure; in any case it should be tested to make certain that it is copper-free. An old foundry ladle, lined with firebrick and faced with the highest quality fireclay, can be very well adapted as a receptacle for the process. If care is taken the bricks will not suffer; at the most a few may be dislodged, and only the facing of fireclay will need to be renewed for every run. The ladle (or similar receptacle) is slowly and thoroughly dried before being used. After the reaction the alloy is allowed to freeze, and the following day removed for crushing. To facilitate the removal of solid lump of ferro-tungsten it is necessary to make it have a substantial taper.

Ventilation Difficulties.

The reaction gives off very copious dense brown fumes so voluminously that most local authorities will not permit the work to be done in the daytime. For the safety of the operators it is necessary to do the work in a well-ventilated building. It may appear superfluous to add that wooden joists are not desirable—the writer has seen one roof which suffered severely from the misguided enthusiasm of a thermit devotee.

The whole of the materials used in the actual process, *i.e.*, the wolframite, aluminium, ferro-silicon, fluorspar, must be in the form of very fine powders. Each part of the charge is completely mixed; everything is kept thoroughly dry; scrupulous care is taken to avoid accidental ignition of any part of the charge.

The reaction is commenced with a small quantity of the aluminium mixture, and when it is well established the reduction is made entirely with the ferro-silicon mixture. If the action subsides it is revived by means of a standard mixture containing either aluminium or aluminium and silicon.

On a small scale the work may be done by shovelling the charge into the crucible. This method, however, is not always satisfactory, and it is far better to employ a hopper, the feed of which is actuated by means of a worm.

Towards the end of the process dry ground fluorspar is added in order to give a thin fluid slag. The separation of slag and metal constitutes the most difficult and important part of the operation; difficult because the time to change the character of the slag is limited to a few minutes; important because if it is unsatisfactory the whole of the solid metal will have to be crushed and put over a Wifley table to separate the slag and metal, an item which adds to the cost of production. The presence of the slag in the ferro-tungsten makes it very objectionable for crucible steel manufacture, for the slag corrodes the pots and gives rise to erratic carbon percentages.

Reactions Involved.

Assuming that a 1,000 lbs. of wolframite ore is to be made into ferro-tungsten, and that it has been found that the ore contains a maximum of 65 per cent. tungstic oxide (WO_3), 6.5 manganous oxide (MnO), and 0.2 per cent. of copper and tin, the reduction mixtures are calculated upon the following reactions:—

Reduction of the Tungsten.

$$WO_3 + 2Al = W + Al_2O_3 \text{ (I).}$$
$$2WO_3 + 3Si = 2W + 3SiO_2 \text{ (II).}$$

Reduction of the Iron.

$$3FeO + 2Al = 3Fe + Al_2O_3 \text{ (III).}$$
$$2FeO + Si = 2Fe + SiO_2 \text{ (IV).}$$

From these equations, by a simple calculation, it follows that:—

(1) 100 lbs. of WO_3 will require for reduction either 18.1 lbs. of silicon or 23.3 lbs. of aluminium.

(2) 100 lbs. of FeO will require for reduction either 19.5 lbs. of silicon or 25 lbs. of aluminium.

As an example, it will be supposed that the wolframite available contains:—Tungsten oxide (WO_3), 68.75; ferrous oxide (FeO), 17.96; stannic oxide (SnO_2), 0.21; manganous oxide (MnO), 5.58; and silica (SiO_2), 0.50 per cent.

The powdered ferro-silicon contains 92.10 per cent. of silicon, and the granulated aluminium is practically chemically pure.

To reduce a 1,000 lbs. of the above ore the main charge will consist of 800 lbs. made into a thermit mixture with the ferro-silicon. By calculation from the figures previously given, it follows that 800 lbs. of the ore contain:—

550 lbs. of tungstic oxide and 144 lbs. of ferrous oxide. The former will require 99.5 lbs. of pure silicon and the latter 28.8 lbs. As the available ferro-silicon is 92.1 per cent. of silicon, the total ferro-silicon powder for the 800 lbs. charge will be 140 lbs. The remainder of the charge will then be made up from 200 lbs. of ore and 43 lbs. of aluminium.

In addition to the above, there will be required an ignition mixture of potassium chlorate and aluminium powder, some lime, and also fluorspar. The charge sheet for the reaction will thus be as shown in Table I.

Table I.—Typical Charge Sheet for Making Thermit Ferro-Tungsten.

Material.	Weight in lbs.
Ignition powder.	
Potassium chlorate	10
Aluminium powder	5
Starting charge.	
Wolframite ore	200
Aluminium powder	43
Main Charge.	
Wolframite ore	800
92% Ferro-silicon powder	140
Lime. (Buxton)	18

Into the dried but not hot crucible is put the ignition powder, mixed with about 7 lbs. of the starting charge. This is fired by means of an ounce or so of a mixture of 50 per cent. sodium or barium peroxide and aluminium powder placed in an iron spoon, lit with a match and dropped into the small charge in the crucible. The reaction, which starts with terrific vigour, soon becomes well established as further quantities of the starting charge are added. The silicon powder mixture is then fed in by shovelling, or by means of the hopper-feed. The object is to secure a steady reaction, and also to obtain the ferro-tungsten fluid sufficiently to permit of a separation

of the metal and slag. With this in view, towards the end of the reduction the remainder of the starting mixture is added, immediately followed by 12 or 14 lbs. of powdered fluorspar.

When the reaction is completed the ferro-alloy is allowed to cool to a dull red; it is then knocked out of the crucible and quenched with water. If the reaction has been successfully carried out there will be a complete separation of slag and metal. The lump is then crushed to walnut size, sampled and assayed.

From the charge cited above the pig would be approximately:—Tungsten, 85.5; carbon, 0.07 to 0.17; silicon, 1.5; aluminium, 0.8; and manganese, 0.3 per cent.

It will be observed that in the calculation of the charge no account is taken of the manganous oxide. Actually very little of the manganese in the ore enters the alloy, the bulk of it being found in the slag. Further, there is never a complete reduction of the iron, for the slag always contains ferrous oxide. The recovery of the tungsten varies from 90 to 98 per cent. The latter percentage, however, is seldom attained, and 95 per cent. may be taken to represent excellent working.

Typical Compositions.

Table II gives the analyses of numerous thermit ferro-tungstens produced by different makers.

Table II.—Typical Compositions of Thermit Ferro-Tungstens.

	C.	Si.	Al.	Mn.	Sn.	Cu.	W.
"A" ..	0.19	1.00	1.20	0.34	0.02	Tr.	82.2
"B" ..	0.076	1.20	1 40	0.25	0.01	Tr.	86.2
"C" ..	0.082	0.75	2.10	0.40	0.015	Nil.	83.0
"D" ..	0.065	1.45	0.80	0.12	0.015	Tr.	85.2

It will be observed that in every alloy the combined silicon and aluminium totals up to about 2.5 per cent. The percentage of each is partly determined by the relative amounts of silicon and aluminium used. For example, in alloy "A" half of the reduction was made by aluminium and half by ferro-silicon, whereas in alloy "D" the bulk of the reduction was accomplished by means of ferro-silicon. Thus if it is desired to keep either the silicon or the aluminium low the charge may be, within limits, calculated to give the desired composition.

Wembley's Conference Programme.

The programme of conferences to be held during the course of the British Empire Exhibition at Wembley next year is steadily growing. Already some twenty conferences have been arranged and definite dates assigned for them. Chief on the list are the first World Power Conference, which the British Electrical and Allied Manufacturers' Association is organising, and the Mining and Metallurgical Conference, in which the principal organisations connected with the mining industry, the Institution of Mining Engineers, the Institution of Petroleum Technologists, the Mining Association of Great Britain, the Iron and Steel Institute, the Institute of Metals, and the National Federation of Iron and Steel Manufacturers, are taking part.

Three conference halls, which are now well on the way towards completion, are being built at Wembley. These can accommodate respectively 200, 600 and 1,800 people.

The following bodies have now been definitely given dates for the conferences they are arranging:—British Engineers' Association, April 30; Town Planning Institute, May 5 to 10; British Engineer Association, May 21 and 22; Institute of Mining and Metallurgy, June 3 to 6; Electrical Contractors' Association, June 18; British Electrical and Allied Manufacturers' Association (World Power Conference), June 30 to July 12; British Chemical Association, July 10; British Engineers' Association, September 17; Decimal Association, October 1; British Engineers' Association, October 15 and 16.

Arrangements have been made between the British Science Guild and the National Joint Council of the Trade Union Congress and the Labour Party to hold a conference on science and labour on July 31 and August 1 and 2.

The following bodies are arranging conferences for which dates have not yet been definitely fixed:—Institution of Naval Architects, the Institute of Automobile Engineers, and the Institute of Sanitary Engineers.

"Moulders" of the Industry.—No. 21.

Mr. H. Field.

Mr. H. Field was born in Birmingham in 1892. After receiving a secondary education, he was appointed assistant in Metallurgical Department of Birmingham Municipal Technical School, under the late Mr. A. H. Hiorns. During four years there he passed through the whole of the courses in metallurgy and allied subjects, and devoted a considerable amount of time to investigations and research work.

In 1911 he entered the chemical laboratory of the Birmingham Small Arms Company, Limited, and in 1912 moved to Messrs. Capper Pass & Son, Limited, of Bristol, whose business is the smelting of copper and tin ashes, etc. Ten years ago he was appointed chemist to Messrs. John Harper & Company, Limited, of Willenhall, Staffs., and organised the laboratory department, later taking control of all melting operations in order to co-ordinate the work of the laboratory and the foundry. In addition to grey and malleable foundries, which specialise in high-class light cast-

MR. H. FIELD.

ings, these works deal with the complete manufacture of hardware, but most of his time has been given to the foundry side of the business. In particular he has given much attention to perfecting semi-steel mixtures, and adapting them where necessary to the lightest of castings, where softness for machining is an essential.

Mr. Field joined the Birmingham Branch of the Institute of British Foundrymen in 1914, becoming Branch-Secretary in 1919 and Branch-President in 1921, at the early age of 29 years. In 1922 he acted as Chairman of Convention Committee for Birmingham Conference. Mr. Field has given Papers to the Birmingham and Coventry Branches, and in the current session he is to lecture before the Birmingham and East Midlands Branches. He is also a member of the Iron and Steel Institute.

Italy and Spain.—It is officially announced from Madrid that a trade and navigation agreement was signed between Spain and Italy recently. The official announcement says that under the terms of the agreement the two Governments agree to appoint within six months of the agreement coming into force a committee of experts to examine the measures which the two Governments might be able to take in common for the promotion of the mutual exchange of raw materials, more especially the export of coal from Spain to Italy. The treaty was to come into force on November 10.

Making and Testing Test Bars.*

By J. S. Glen Primrose, A.R.T.C.

After the recent surfeit of testing materials of all kinds we are now coming to realise that the need of testing the physical properties of the metals especially is a very real one, and has come to stay. Whilst the actual pressure of production was upon us, the performance of the tests was accomplished, in many cases, with little realisation of the benefits accruing from so multifarious a repetition of the same operation. Now that we have had time to consider the matter in its several aspects in times of less fevered activity, a better grasp of the essentials and reasons for things has come about, and is still being worked out.

Test Bars for Steel.

It is perhaps natural that those branches of metallurgical activity which have to meet the most stringent tests and rigid specifications, often of a very varied character, should be the best organised and equipped for meeting these drastic demands. The steel trade, for instance, has for long been the foremost in protecting itself with a strong array of chemical and physical safeguards for its interests, and here we find testing carried on with the utmost routine precision. Not only have exacting requirements in regard to chemical composition to be continuously met, but also accompanying physical properties have to be attained which almost seem incompatible in many cases.

It is, of course, obvious that with such simple sections as rounds and flats, the selection of test pieces is a comparatively simple one. For the smaller sizes all that is required is simply to have a length cut off, even shearing will do, and the specimen can be placed directly into the requisite testing apparatus without any preparation whatever. With the larger dimensions, which—if tested whole—would necessitate an unwieldy if not impossible size of testing machine, it is customary to saw out the portion small enough to act as the rough section which has to be turned down for rounds or shaped out for flats to give the cross-sectional area, in breaking which the load required falls within the capacity of the machine available.

Testing Wire.

With sheets or plates the procedure can also be adopted of shearing off lengths in two directions of the rolling, then removing the distorted portions or edges by shaping, and the specimen is again ready for the simpler tests. Wire falls into a category by itself, for not only has it to be tested in the usual tensile methods in parts taken from both ends of the coils as drawn, but certain special tests have to be performed in addition, which include the twisting of the specimen both in direct torsion and by winding it upon itself and off again, together with an alternate bending until fracture occurs. The various kinds of heat treatment and several kinds of mechanical treatment necessitate a close watch being kept upon the strength and other properties at each stage of manufacture. As a rule, only short lengths of the wire are needed for the test specimens, but definite lengths are usually prescribed for making elongation tests. Long lengths have in certain special cases to be tested for electrical resistance, which must also fall within comparatively narrow limits.

By far the greatest amount of work still fails to be covered in the direction of standardising the means of taking tests of castings, whether in iron or non-ferrous metals. The large number of independent inspecting bodies and engineers will be likely to hamper progress in this country, which has no similar regulating authority to compare with the American Society for Testing Materials. Each tries to set up as an authority for himself, and even then changes the standards to suit different customers who are powerful enough to demand certain special forms to enable comparisons to be drawn with old-fashioned results, which may or may not have any reference to real practical value or performance.

* A Paper presented to the Lancashire Branch of the Institute of British Foundrymen, Mr. R. A. Miles presiding.

Testing Cast Iron.

The general tendency in iron foundries has for long been in favour of the rectangular sectioned bar cast on with the casting, and only removable after the affixing of a seal or stamp of the inspector. This is without doubt in many cases a hard condition to fulfil, and the alternative of separately cost bars in the presence of the inspector is only a stage removed from the former in general inconvenience. In many cases the common sizes adopted bear no relation to the size or section of the important places in the casting, and it almost appears as if a fashion amongst engineers determined whether the 3-ft. bar, 2-ft., 18-in. or 12-in. bar would be required for making the customary transverse bending test. This really constitutes merely a soundness test of the metal in the bar itself, and takes no consideration of the similarity or difference in the constitution between the test pieces and what they are intended to represent. The composition may closely approach in the bar what it is in the casting, but the all-important structure of the components of the metal in the two cases is usually left out of account.

The day of a standard test bar is no doubt looming ahead, and should undoubtedly be welcomed for the simplicity it introduces and also the ready comparisons it enables to be made. The work of the Test Bar Specification Committee of the Institute is very praiseworthy, and deserving of a reasonable trial—that is to say, wherever it can be fitted in with the routine of the foundry wishing to assist in the education of the regulating authorities, who must first of all be convinced of the desirability of the rather drastic changes suggested. The moot point of the round instead of the square or rectangular section will doubtless have many opponents, but it really seems a step in the right direction to eliminate the harmful effects of cross-grain crystallisation effects at the corners. The hardness there imparted by the more rapid cooling is not conducive to greater strength, but is more often a source of weakness, giving a greater predisposition to form cracks liable to cause premature failure of the material under test.

Inapplicability of Formula.

The rule hitherto followed of making the load requirements vary for different lengths of transverse test bar in cast iron, with the mathematical formula connecting the two, is not generally fair to the founder, but in that case no allowance is made for the alteration in mass of metal used. For example, the class of metal which will be called upon to withstand 30 cwt. on a 36-in. span, when asked to give 90 cwt. on a 12-in. span, with the same 2-in. by 1-in. section, is really receiving a more exacting test, which is more difficult to meet without taking extraordinary precautions in the casting conditions of the smaller bar. The point is, of course, often lost sight of that the moulding and casting of the test bars, especially in the case of repetition ones made separately from the castings, is a very important piece of work, demanding more care and attention than is usually bestowed upon it, and in this way unnecessary risks are run of having perfectly good castings rejected because the bars representing them have been improperly or poorly made.

Position of Cast-On Bar Important.

In the case of the cast-on bars, it is necessary to observe closely that the position of the bar is not such as to make it act as a drain for the impure portions of the metal as it rises in the mould, thus entrapping the least desirable cold metal and even skum in the portion which is most desired to be sound and strong. It is often difficult to persuade anyone who sees the bar broken, in the event of such a mishap arising and the bar being unsound, that the remainder of the casting is not in a like condition.

XUM

Non-Ferrous Test Bars.

In the case of non-ferrous metal castings it is almost universal to adopt the circular-section test bar, but the form of this prior to machining has been the subject of much controversy, both in this country and the United States. The plain, round stick about 1 in. in diameter for the general run of jobbing-shop castings of small and medium weight has found most general acceptance here, and this can be cast flat either in a separate box holding a pair, or in special inspection cases attached to the casting itself. This should be done at a suitable place where there is no draw likely to occur, either to the detriment of the casting itself or to the test bar. Chills or denseners should not as a rule be adopted to influence the rate of cooling of the test bars at a different one from that of the casting, unless very thin work is being produced. When the inspection calls for the test bar to be taken from the actual casting, such as a round billet form, it is certainly advisable to cut it right through the centre and take a side portion rather and turn down the billet to leave the test bar with its centre at the core of the original billet. Apart from the possible segregations there, there is always a looser joining of the advancing crystal formation just at that point which is frequently bored out in the course of manufacture, and not left in the finished article at all.

The alternative suggested to this form, which undoubtedly looses much of the denser and sounder metal near the skin of the test bar as cast, is the American one of casting the bar to size, and just skimming the surface to get a smooth circumference prior to testing in tension. This always gives a higher value when the bar is sound, but care must be exercised in preventing the setting up of internal strains in the case of large shoulders or heads being cast on. The barrel-shaped blank goes to the opposite extreme, and gives a much weaker bar than the material in the casting, unless in the case of heavy sections, which cool slowly. This latter shape has the further disadvantage of requiring much more machining to bring it down to the final test diameter.

Runners as Test Bars.

The ordinary runner and riser is sufficient for the commoner alloys which do not exhibit excessive shrinkage, but if there is, then the recommended method adopted is to have the whole length of the test bar fed by a wedge of metal above it. This is attached by a web $\frac{1}{4}$ in. thick, which can readily be parted off by an ordinary band saw when the metal is cooled off. Such a method often gives higher test values in the bar than if it is cut from the casting itself.

Tensile Testing.

This is perhaps the most universally used method of arriving at the strength of materials of engineering importance, and when properly conducted it certainly affords most valuable information. The methods of performing it have been varied and improved very considerably within recent times, and the various measurements made in connection with it can now be made with high degrees of accuracy and reliability. It perhaps attains greater importance in the case of the ductile metals and alloys than in the case of cast iron, for in the former the indications of the elastic limit yield point and actual breaking strain can be noted and sometimes autographically recorded, in addition to the maximum tensile stress, which is the highest reading got during the conduct of the test. Subsequent determinations give the amount or percentage of both elongation and reduction of area, and these, taken all together, give most useful data to the engineer and designer to enable him to use the most suitable material for definite purposes. Standard sizes have been selected for the diameters or cross sectional areas in different cases, with the correct proportion of gauge length to make comparisons easy and simple to understand. One point which is often not fully enough emphasised in this test is the necessity for ensuring the absolutely straining or axial pull of the material; preference should always be given to the attachment of the ends or heads, whether screwed or shouldered, which embodies the principle of the spherical seating. Whilst a ductile material will stretch or yield a little to accommodate itself to slight irregularities in this respect, cast iron is most susceptible to any defect in this direction, and it therefore behoves those responsible for the operation to adopt some simple form of the spherical seating grip to get the full value from the material under test.

Transverse Testing.

In the transverse testing of cast iron, even more so than in the tensile test, great care should be taken to ensure a perfectly steady application of the load increase; this is a point which is often ignored, with disastrous results. Roller seatings for the test bar are not so important as in the bending test of ductile materials which undergo a very great deformation, but for the short span test bars now coming into use it is important that a much finer method of reading or recording the deflection should be adopted. Details were given of a simple automatic device which indicated the transverse test-bar deflection to the 1-200 of an inch. Attempts have been made to get a connection between the tensile strength of cast iron and its transverse strength, so that by taking a simple determination of the latter the former can be derived from it. The theoretical formula is simple enough, but the value of the multiplying constant has to be modified from the purely mathematical one by the results obtained in practice, and even then it ceases to be a constant for all classes of grey iron structures.

Compression Tests.

In view of the fact that cast iron is mostly employed in positions where the chief stress upon it is one of compression and not tension, it is regrettable that more attention is not paid to this form of testing, as it is most informative and useful. Naturally, the loads used are much greater than in the transverse test, where both tension and compression stresses are brought into play; or in the purely tensile test. Unlike the tensile tests, the length of specimen is of importance, for the cast iron fails finally by shearing at an angle of approximately 45 deg. to the direction of loading. This means that if the test piece is too short in relation to its length the shearing planes are not free to move, but are bridged between the compression plates, with the result that an enhanced value is got. The length should be at least $1\frac{1}{4}$ times the diameter for a round specimen, which is usually to be preferred to a square one, the edges of which introduce complications. Too long a test piece is not to be advised, as sidewise distortion may lead to false results and even to slipping. A case of a compression test bar which had been considerably bent without fracture was exhibited.

Hardness Testing.

Hardness is a property of metals which has a variety of meanings, and several kinds of hardness must be noted. The simple penetration test with a pointed cone or rounded ball gives a measure of only one of these, and care should be taken to express its value in the proper units, which were not merely numbers, but a stress per unit of area. The older method of measuring the diameter of imprint was deprecated as giving erroneous, usually much too low values, the latest research work showing that the usual discrepancy of 20 per cent. from accuracy being entirely eliminated by taking the true depth of imprint by means of a simple indicator. The calculation of the hardness value from this measurement was much more simply effected than by the other means. The relation of load to ball diameter was formerly considered as being regulated by a simple factor, but the new method does away with this necessity of observing any relation within the limits of practical load applications.

Impact Testing.

Shock tests commonly made for finding the resilience of steel in a transverse direction were coming to be applied to other metals, including cast iron more commonly, and in certain Continental specifications these repeated shock tests actually superseded the transverse test. The

simplest impact tester was the swinging pendulum type, but certain provisos had to be taken into account in order to get a true reading. The cantilever form with a glancing blow was only of service for very brittle materials; for the more tough metals the beam form of notched bar was generally adopted. The tensile-impact test so useful for steels in wire or rope form was not yet applied to cast iron, but the compression-impact test would be found to yield useful data when more information had been collected on the subject. The drop tup method of repeated impact test was specially adaptable to increasing force of blow, but the general form of fatigue tester in this way was now the swinging pendulum form with double effect, striking the blow on alternate sides of the specimen until fracture occurred.

Torsion Test.

This form of directly applied stress or with alternate direction of the application of the twisting couple, gave a useful indication of the service of the metals when they were subjected to such a form of loading in actual practice. It was specially important for finding defects in wires, and also for determining the utility of shafts of ductile material, but so far it had not been much applied to the testing of cast iron.

Abrasion was a form of testing which was too often left for actual practice to try out on the material used. The reproduction of the actual working conditions was often very difficult to attain in a laboratory experiment, but there was no reason why a simple form of apparatus should not give a series of useful comparisons which was much needed at the present time, when increased speeds in nearly all types of mechanisms brought the question of resistance to wear prominently before every manufacturer of machinery and bearings.

Suitable machines for performing the tests above enumerated were described in considerable detail, some of them being illustrated and explained for the first time, as they were of quite recent design. In the interpretation of results obtained, the need for the correlation of the physical structure of the metal involved with the mechanical tests, and in most cases also with the chemical composition, was explained with relation to specific cases, which were quoted and illustrated by means of photo-micrographs and tables.

DISCUSSION.

MR. F. W. ROWE said no serious criticism could be offered to the Paper, as everyone would agree with all Mr. Primrose had said. He presumed that the majority of the members were interested in the testing of cast iron or the non-ferrous metals in the cast state, and for these metals very few could find time to do more than tensile, transverse and hardness tests.

Brinell Figures Need Revision.

He could corroborate Mr. Primrose's remarks about the value of the depth of imprint taken by an indicator in hardness tests. This was especially true in the case of soft material. On cast non-ferrous alloys it was impossible to make a satisfactory hardness determination by measuring the diameter of the imprint in the usual way, as the flow of metal and the consequence ridge varied so much with different loads that not even comparative results could be obtained. Mr. Primrose would, he thought, like it to be emphasised that in testing the hardness of cast iron a large ball and heavy pressure gave a far more reliable indication than a small ball with a small pressure. He (Mr. Rowe) had recently made a number of experiments with a new small ball hardness testing machine, and with cast-iron specimens the variations with a small ball were far more serious than in the ordinary method of testing.

Importance of Impact Testing.

He thought Mr. Primrose might have emphasised more the value of impact testing of cast iron. He rather thought this important method of testing cast iron had been very much neglected from a scientific standpoint. Certain elements, notably phosphorus, failed to show their effect on the strength of cast iron in the ordinary tensile and transverse tests, but had a very great influence in the values given in the impact tests. A large portion of British commercial cast-iron castings must have a strong resistance to fracture under shock. Many foundrymen quite rightly base their opinion of the strength of the cast iron by the ability of a bar held in a vice to withstand fracture by hammer blows. The impact test was merely this very old method of testing cast iron placed on a scientific basis. Personally, he had used the standard 120 ft-lbs. Izod impact machine, using a 20 mm. square bar 75 mm. long, with no notch. One obtained some very interesting results with these tests. Cast iron, for instance, which showed almost identical tensile and transverse figures, often gave widely different results under impact test.

The Bearing of Knife Edge on Results.

MR. H. R. PITT, referring to the transverse test, said there was no doubt that the form and dimensions of the knife edge had very great influence in the breaking of the specimen. In a rectangular or square bar the whole of one side of the bar is under compression from the knife edge. It would be interesting to learn what was the best form of knife edge for that test in the lecturer's opinion. The round bar seemed to him to be a very good thing for relieving the strains that were set up in casting angles. At the same time, a round bar was not necessarily true, and it would make a great deal of difference to the test if the bar was even a fraction of an inch out of true cylindrical form. That was a factor which had to be overcome, possibly by a very slight machining, which was allowed under certain other forms of test.

Standardising Brineli Figures.

Could Mr. Primrose say whether the Brinell hardness had all the value it appeared to have in cast iron? Foundrymen met difficulties associated with the varying hardnesses of the exterior and the interior of the casting, due to casting conditions. Brinell figures must of necessity be as far as possible standardised and stabilised, otherwise it could only be more or less a loosely comparative test.

The uncertainties which attended the tensile test were very marked, more marked in cast iron than perhaps any other metal. In the case of an ordinary casting one had a material which had next to no elasticity, and the slightest deviation from perpendicular or the slightest deviation from the regularly applied load had a disastrous effect upon the resultant value. Recent investigations by a leading metallurgist had shown that varying the load on the speed of application of a test piece altogether did away with the regularity of result. If loaded to about two-thirds of the breaking stress and left in that position for some time the result was modified.

Question of Fatigue Raised.

He agreed with Mr. Rowe about impact testing in cast iron. It seemed to have been for a long time a neglected sphere of study. One great feature of cast iron was its weakness under shock, and whatever test other than the impact test was applied to it, one had really no indication of its behaviour under shock. It would be most interesting if the Institute took this matter in hand. He was certain it offered a very useful field for investigation, to decide in what conditions cast iron could best be tested to measure its resistance to shock. The question of fatigue was very much allied to that. The fatigue effect upon cast iron seemed to be somewhat obscure and unknown, and foundrymen could well do with more information regarding it.

Questions Discussed at International Committee Raised.

MR. JOLLEY said he did not propose to criticise the Paper, but he had a few questions to ask. He had attended the meetings held in connection with the Institute to try to get an international test bar fixed, and many questions had come up which they were not quite certain about even now. Perhaps Mr. Primrose could give some help. What did engineers want? Did they want a test bar to represent the casting, or did they want it to represent the metals which were put into the casting? How many sizes of test bars would Mr.

Primrose suggest they should adopt? Did he think the round bar or the square bar the better? Then he would also like to hear Mr. Primrose on the Universal machine for testing, which was said to have a dial which gave a deflection test. Did that deflection indicator give a permanent deflection test, or did the needle go back when the bar was broken? What method of dealing with the specimen did he think it best to use when taking the deflection of round bars or square bars in a transverse test? What was the correct rate of application to apply the load to these tests? The members were much indebted to Mr. Primrose for his interesting and elaborate lecture, and he proposed a vote of thanks.

MR. MARKLAND, in seconding the motion, remarked that he remembered many years ago when cast iron was being made for girders the test bar was cast attached to the beam. At that time he did not know much about the work, but he found out that a special charge was put in to the shank which was used to run the bar.

The Author's Reply.

MR. PRIMROSE agreed that there was a lot of work to be done in the investigation of cast iron. In many respects it was a virgin field, and the impact test was a key which should open a new doorway to the inner meaning of its structure. One part of the subject, the interpretation of crystals, could only be done finally and fully by the microscope.

In making the transverse test for cast iron he always used the roller bolster, such as was employed for the bending of steel bars, so that there was no grip on the metal, and it could move. Therefore, there was no bite into the metal. The middle support was also a roller bolster for rectangular and square bars. It could also be used with round bars, but account must be taken of the indentation put into the bar, because that would add to the permanent deflection. More useful would be a cup support in which the bar was actually held in a cradle lengthwise instead of transversely. That would support the metal all round. How far that could be accomplished in practice he was not prepared to say, as he had not seen it used with such support.

The hardness test gave the surface hardness on the skin at the spot which was tested; it did not show the hardness of the core. In cast iron they had a hardened surface or skin, and when this was machined off it gave a lower value. Going further in the value became lower. With cast iron the tensile test was only of value when made with a spherical seating. If it was not a spherical seating there was a sideways application of the load, and the bar had a lower tensile value. There was a duplex stress, and if one applied two stresses to any metal it would fail in one of them at a lower value than if it was a pure single stress.

In addition to the transverse-impact, the compression-impact test of cast iron would also be found useful. It could be taken by dropping a hammer straight on the specimen or with a swinging pendulum hitting it against a suitably fixed heavy anvil.

He was afraid Mr. Jolley had put to him the very questions which the Committee were asked to determine. So far as he could he had given pointers or indications why, in his opinion, the circular bar would be preferable to the square bar. A great deal of work had been done to show engineers that the circular bar would inform them not only of the metal in the bar but also, to a certain extent, in the casting itself. With square corners and what he called cross-plane crystallisation, what would happen to the bar? There would be planes of weakness. They wanted to get rid of the cross planes and make them bend instead of butt. That, he thought, was one of the great secrets of the success of the circular bar. It had been adopted in America and on the Continent, and engineers in this country had been too conservative in sticking to the rectangular test bar. If engineers could be got to fall in line with American and Continental practice it would be an advance, but the foundryman and the metallurgist must convince the engineers that that was so.

It was some advance on the pathway to an international specification that three sizes of test bars had been suggested. It seemed to be preferable to using one size under different loads. It was unfortunate that in this country there was not an organisation like the American Society for Testing Materials, which could circularise all those within its fold and get a vote which was recorded in its "Journal." He did not know whether it was too much to ask the Institute to take cognisance of this matter. If some form of collaboration could be arrived at it would be a great advance.

With regard to the method of testing for deflection, the machine he had mentioned had an upper bolster. The pressure was not along the crown of the machine; it was held down, and the test bar was brought up against it. Usually in this country it was pressed on, but this method brought the bar against the bolster and carried it down till it had touched the crown. When it touched that it lifted a little brake, on which was a little square plane corresponding with zero on the dial. As the bar rose the dial rotated. When the bar broke a little spring brought the bolster down and clamped the brake on to the dial exactly at the final deflection. One or two people in this country were using that machine. It gave a final deflection. The pointer on the load dial carried a loose pointer, and at the maximum it fell off, leaving the loose pointer at the maximum without giving it a kick-off, as most load indicators did. With regard to what Mr. Markland had said, it was unfortunate that in some hands the use of test bars had been abused, but nowadays the reason or excuse for such conduct was becoming less. When foundrymen knew their metal they could have confidence in it, and with proper control there need be no fear of not meeting the specifications which at present were in force.

Trade Talk.

WILLIAM SHARPLES & COMPANY, LIMITED, Irwell Foundry, Ramsbottom, are relinquishing their business.

THE IMPORTS OF FOREIGN IRON ORE at the Senhouse Dock at Maryport last week amounted to about 3,000 tons.

THE BEESTON FOUNDRY COMPANY, LIMITED, will in future trade under the style of the Beeston Boiler Company, Limited.

THE EMU SPELTER WORKS, Skewen, which have been at a standstill since 1918, are to be restarted by the Neath Spelter Company.

THE FURNIVAL STEEL COMPANY have removed their smiths' department from the Rodger Lane Forge to Furnival Street, Sheffield.

HALL & PICKLES, LIMITED, Port Street, Manchester, have opened a branch office at Lonsdale Chambers, Lichfield Street, Wolverhampton.

THE ANNUAL DINNER of the Institution of Mechanical Engineers will take place in the Connaught Rooms, London, on Thursday, December 13.

THE ROOF OF ONE of the open-hearth furnaces at the Wigan Coal & Iron Company's works collapsed on Saturday last, eight men being injured.

GLOVER & WOOD, LIMITED, Larchfield Foundry, Hunslet, Leeds, have removed to new premises at the Victoria Foundry, Victoria Road, Leeds.

PEASE & PARTNERS, LIMITED, have given instructions for two of the three furnaces at their Tees Bridge Works, Stockton, to be put into blast again.

CHANCE & HUNT, LIMITED, chemical manufacturers, of Oldbury, have removed their London office from 61, Gracechurch Street, to 5, St. Helen's Place, London, E.C.3.

CRAVENS, LIMITED, of Sheffield, have secured a contract from the London & North-Eastern Railway for 32 carriages, to be used on the Cheshire Lines Committee's system.

JOSEPH EVANS & SONS, Culwell Works, Wolverhampton, have removed their London offices from Salisbury House, London Wall, to Craven House, Kingsway, W.C.2.

CHARLES LATHE & COMPANY, LIMITED, of the Moat Foundry, Tipton, are enlarging and modernising their works, new plant being installed, including two cupolas, blowers, electric hoists, etc.

AFTER BEING CLOSED DOWN for a considerable time, the ironworks of Tolley, Sons & Bostock, Limited, the Green, Darlaston, have re-started. About 200 of the former employés have been set on.

CONSIDERABLE DAMAGE was caused recently by a fire at the works occupied by the Rotherham Steel Strip Company, Limited, and the Rother Boiler Company, Limited, Baths Foundry, Westgate, Rotherham.

A Consideration of Some Mechanical Tests on Cast Iron.*

By Prof. F. Siegle, of Nancy Technical College.

(*Continued from page* 436.)

MECHANICAL PROPERTIES OF HEMATITE IRONS AND OF SEMI-PHOSPHORIC IRONS.

The very distinct relationships exhibited through the average results of tests on the hematite irons, and the appearance of their fracture as illustrated by Fig. 1 no longer apply when the phosphoric irons are considered. The average shear and transverse results increase as the texture becomes less graphitic, but not to a great extent. The diameter of the Brinell impression decreases as the texture becomes less grey, but there are frequent contradictions. Moreover, the Brinell impression often exhibits quite considerable variations at different parts, even of a simple bar, according to the distance from the surface, etc.

The author has never encountered highly-phosphoric irons which would give the high tensile, transverse and impact tests shown by curves "a" and "b," Fig. 1, which refer to hematite irons. It appears possible, however, to have phosphoric irons approaching the mottled white which would give higher resistance to shear and transverse if very gradually applied. Such irons, however, would be extremely brittle and liable to porosity; they would, in addition, be impossible to machine.

How the Brinell Test Compares.

From all that has been said it is evident that it is not possible to deduce, even approximately, the mechanical properties of a cast iron simply from the Brinell impression. The relationships existing between the Brinell impression and shear, tensile and transverse tests are not the same for hematite and irons having a phosphorus content of 1.8 to 2 per cent. It would be interesting to investigate irons with an intermediate phosphorus content to see how they behave with regard to these factors. The results of the Brinell test would conform rather more closely to working conditions, but even then there are many and serious anomalies. Speaking generally, penetration is very much easier than planing or sawing, and it is possible to have a cast iron which, whilst exceedingly difficult to machine or cut, will yet give a Brinell impression of 4.2-mm. dia. Other irons relatively much easier to machine might give an impression only 3- or 4-mm. dia.

Mechanical Tests and Quality.

Coming now to the question of correlating the results of mechanical tests and the quality of the material. For practical purposes, the taking of shear and Brinell tests on small test pieces cut from the casting as suggested by M. Frémont will give useful reference points relating to the metal at that part of the casting. With reference to phosphorus, it should be remembered that this element can be very useful in a number of cases on account of the fluidity it imparts to the metal for casting, in spite of the smaller resistance to impact, than is shown by the hematites and the slight raising of resistance to tension and deflection. The best proof of the practical usefulness of these irons is shown by the importance of the foundries of the Eastern Provinces of France, which operate on first and second meltings with metal containing 1.50 to 2 per cent. of phosphorus. It is interesting in relation to this subject to quote from the "Iron Age" for December 21, 1922, an article which, among other things, mentioned the impression caused in the United States by the use of phosphoric pig-iron from the East of France, imported during the miners' strike when there was a shortage of the metal.

Influence of Phosphorus on Quality.

The author of this article says: "Perhaps the most remarkable feature of the entire recent experience with foreign iron in this country has been the discovery that the high-phosphorus grades from France, Luxembourg, and Belgium can be employed in practically every branch of foundry work, not only without lowering the standard of the work, but even with improvement in many instances. At the outset it was considered that these irons would prove to be suitable only for the manufacture of cast-iron pipe, etc. Just at the time the first shipments began to arrive in this country (America), however, the shortage of all grades of foundry iron was most acute; consequently high-phosphorus, Continental irons found their way into the cupola mixtures of foundries engaged in nearly every branch of grey-iron foundry production. Much to the surprise of everyone concerned, the results obtained by users of these irons were decidedly satisfactory in nearly every case. Even firms producing engineering castings found that as much as 40 per cent. of these irons could be included in their cupola mixtures without appreciable loss of tensile strength, etc. Many smaller firms reported that the use of these irons improved their products in soundness, appearance and machinability. The irons have been especially successful in meeting the requirements of manufacturing small, complicated hardware, etc. So, if the presence of phosphorus in these irons has lead to a better product from the point of view of soundness, less shrinkage, and with practically the same tensile strength, etc., it would seem logical produce such phosphoric irons in America. The introduction of these foreign irons into the United States must have a profound influence on the metallurgy of cast iron in the country."

Soundness Essential.

In the end, sound castings must be the objective of the founder. For of what use is it to have an iron which possesses the most remarkable mechanical properties in the sound parts but which gives castings containing a great many defects, particularly when the defective area is one which is subjected to severe stresses or to the rubbing action of working parts. There are many cases in practice in which the design of parts on merely theoretical lines would lead to extremely thin castings, whereas the application of empirical rules, which embody important factors relating to minimum permissible thicknesses, enables the parts to be produced commercially. It often happens that the machining of a casting is of the highest importance. Every effort, then, must be made to improve the machinability of the material by suitable annealing.

Annealing Grey Iron.

The effect of this annealing—if properly carried out—is all to the good, even if, as a consequence, the diameter of the Brinell impression is increased and the resistance per unit area to various mechanical tests is reduced. The strength of the casting will still be ample because of the increased thickening of walls, etc., made necessary by the demand for soundness—the most important requirement.

Hematite irons of high strength, such as were used for the making of shells, have their uses, but they are limited to parts of simple form in which the cooling is evenly distributed. The composition, or rather the depth of chill, must be carefully adapted to the requirements of each piece so that in certain parts the iron may not be too grey—in which case the benefits of high mechanical properties are lost—or too white—when the material would be brittle and impossible to machine. There are hematite irons greyer than those just mentioned, and of which the shear and transverse strengths are almost the same as those of the phosphoric iron, which can be recommended for such castings as ingot moulds which have to stand up to high temperatures. But for the great majority of castings everything points to the phosphoric irons. Moreover, owing to the abundance of the ores in the Eastern Provinces, their cost of production is low.

* Translated from a Paper presented to the Paris International Congress.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The improvement in the Cleveland iron market noted in last week's report is fully maintained, the welcome settlement of the long-standing boilermakers' dispute having counteracted the disturbing effect of the political disturbance. Consequently the feeling in Tees-side trade circles is distinctly more optimistic, and although the demand is not, perhaps, on quite as considerable a scale as recently, there is a steady business passing. Makers are well sold, and there is every indication that the increased output already announced will be fully absorbed. It is, of course, the home trade which is supporting the market, but export business is now, also, showing some improvement, and the shipments for the current month promise to be considerably heavier than in October. Meantime, while there has been no advance in prices, values are very firmly held at present levels. No. 1 is 107s. 6d., No. 3 G.M.B. 100s., No. 4 foundry 99s., and No. 4 forge 98s. per ton.

The Middlesbrough market for hematite continues to develop strength, and recently sales have been on a heavier scale than in any similar period for several years, while the volume of current inquiries points to an increasing demand. It is true that the stimulus is coming almost entirely from the home trade, but as long as this remains in so healthy a condition makers may regard the relative quietness in export business with equanimity. At this week's market there were no longer any cheap sellers, East Coast mixed numbers commanding fully 101s. 6d. per ton. No. 1 was quoted at 102s. to 102s. 6d. Forward sales were reported at figures above these rates. Messrs. Gjers, Mills & Company, Limited, are putting in another furnace this week. Similar conditions to the above are to be observed also in West Cumberland and North Lancashire hematite markets, and here also prices are firm, but without any material alteration in current quotations.

MANCHESTER.—In this centre of the Lancashire trade some improvement is also reported in the foundry pig market, which continues firm and steady. Consumers of foundry iron in this district would like to be able to secure a small proportion of Lincolnshire pig-iron; but while the North Lincoln furnaces are idle this is not practicable, because of the much higher carriage on the other Lincolnshire iron. It is, however, probable that if there is no relapse in prices North Lincolnshire iron may again come into the market next year. The present demand in Manchester for foundry pig-iron is only very moderate, but allowance must be made for the very active buying which began soon after the middle of October, and continued for fully three weeks. Many foundries have covered their present needs, and even their probable requirements for three to four months, and some for the next six months. At the present moment the usual quotation for No. 3 Derbyshire pig-iron in Manchester is 100s. per ton. Scotch pig-iron is firm at rather higher prices, but there is not much business doing in it here. The Scottish makers are apparently able to do without the Manchester market.

THE MIDLANDS.—At Birmingham last week a much more encouraging view was taken in the outlook in this section of the trade, and there was a quietly steady inquiry. It would, however, be difficult to find makers ready to book heavily for the first three months of next year because it is hoped that further price improvements will take place and the margin of profit is still so narrow that it is desired to keep something in hand with which to participate in the better conditions. Some sellers still find the demand for foundry grades disappointing, the expansion of demand not being so large as they could wish. There is a definite improvement, however, and the more sanguine are inclined to expect still further steady progress. Quotations:—Northamptonshire No. 3 foundry, 92s. 6d.; Derbyshire No. 3 foundry, 92s. to 95s., all net f.o.t. furnaces.

SCOTLAND.—Markets in this area are also developing a firmer tendency, and a fairly active business is passing on home consumers' account. Prices have hardened, and No. 3 Scotch is now £5 5s. at furnaces, but makers are going very cautiously in selling, as even at this price, where smelters have to buy all their raw materials, there is no margin of profit left. The users of Middlesbrough iron have now pretty well all covered their requirements up to the end of the year, and in some cases also for the first quarter of next year.

Finished Iron.

At Birmingham market last week it was apparent that recent happenings in the industrial world have had a favourable effect upon business in the finished material section, and although a full resumption of manufacturing activity before the end of the year is unlikely, the outlook may be summarised as distinctly hopeful in the near future. In the meantime quotations for bar iron are decidedly firmer, the £11 10s. to £12 range for crown qualities being now fairly generally realised, whereas until this last three or four weeks £11 10s. has been weak. At the present rate of progress a definite advance in these lower grades is not far removed. The better qualities have always been fairly firm, makers adhering to £12, or £12 5s., even if they lost business in consequence; and some of them have declined offers rather than work for a price which, they said, would not yield them a profit. There still remains a big disparity between the Continental and South Staffordshire prices for nut and bolt bars, but apparently this competition is not very effective, as the local price has been advanced 2s. 6d. A large improvement in conditions is expected to follow the resumption of work in the shipyards, an improvement, which, of course, will not be confined to this class of iron. Makers of special irons, such as cable iron, have had a very lean time during the shipyards strike. They are now looking forward to much better trade.

Steel.

At Sheffield increasing activity is reported in the steel market, billet prices are stiffening, and locally made soft basic billets cannot now be bought at less than £8 10s., a further rise of five shillings per ton. Other qualities have not varied in price so far, remaining at £10 for medium and £10 5s. for hard. There is a slightly better demand for acid billets, but not sufficient to cause any upward movement in prices, which are £12 10s. for Siemens' and £13 10s. for Bessemer. Open-hearth steel is improving and output is being increased week by week. More business is also being booked for high-speed and other special steels. In the market for alloys the recently reduced prices of ferro-manganese are still maintained for both home and export, but business still continues to be sluggish, particularly on the export side. In the home market, a few small foundry orders are about, but the heavy trades are not yet rushing in to buy at the current figures. The tone of the tinplate market is good, and prices are very firm all round. The manufacturers at their meeting last week raised the minimum selling price for coke tinplates by 4½d. per basis box, but even at this there are few sellers. 23s. 6d. having been freely paid since for shipment over the first quarter of next year, and several transactions were reported on a higher basis.

Scrap.

The general conditions now prevailing in the markets for scrap metal correspond in improvement with those dealing with other raw material, and higher prices are already being paid for heavy steel melting scrap, in Wales up to 95s. per ton and in Sheffield up to 90s. In Lancashire, where heavy steel scrap dropped to 60s. per ton, the price is now 77s. 6d., and at times 80s. on trucks. The demand for cast scrap is slightly better, but the ironfounders have scarcely yet got to work on the rather large quantities of pig-iron which they have been buying recently. If and when the increase in the orders for castings comes there must be a much better demand for good cast scrap for mixing purposes and an appreciation in the values is almost certain. Last week up to 92s. 6d. per ton was paid at Manchester for fine lots of broken machinery iron, and from 90s. to 92s. 6d. per ton seems now quite a general quotation. In Scotland the position of cast-iron scrap remains practically unchanged. Foundries are anxious to secure supplies, and, of course, the steel and iron works are also open to purchase the ordinary quality heavy machinery cast-iron scrap and scrap railway chairs round about 97s. 6d. per ton, with ordinary heavy cast-iron scrap at 92s. 6d. to 95s., and light cast-iron and furnace firebars about 75s.

Metals.

Copper.—Movements in the standard market during the current week, although steady on the whole, have developed some weakness, despite the increasing strength in refined metal as disclosed in recent American advices. The fluctuations in values recorded, however, are restricted within a very narrow range.

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METAL MARKETS—*continued.*

the position being probably affected by the adverse effects of the dissolution of Parliament and the problematical issue of the elections. The American market, although naturally affected by the easier tendency on this side, appears to be keeping fairly firm at about 13.45 cents. So far, producers in the States do not appear to have taken any important measures to restrict their output, but in many parts of the country wages are being reduced. Current quotations:—*Cash*: Thursday, £60 12s. 6d.; Friday, £60 17s. 6d.; Monday, £61 5s.; Tuesday, £62 7s. 6d.; Wednesday, £62 12s. 6d. *Three Months*: Thursday, £61 7s. 6d.; Friday, £61 12s. 6d.; Monday, £62; Tuesday, £63 2s. 6d.; Wednesday, £63 7s. 6d.

Tin.—Values for standard tin quite maintain the strong position previously reported, having during the past week made a further advance of £5, and at one time had the appearance of going to still higher levels. This movement was, however, checked by the withdrawal of American support and the renewal of selling on Eastern account. The outlook for this metal can be regarded as satisfactory in view of the anticipated favourable nature of this month's statistical position, which will appear as usual in the next issue of the Journal. It is officially reported from Kuala Lumpur that 3,447 tons of tin were exported from the Federated Malay States during the month of October, as compared with 3,026 tons in September and 2,837 tons in the corresponding month of last year. The total export for the ten months of the current year is 30,989 tons, as against 29,277 tons last year and 28,211 tons in 1921. Current quotations:—*Cash*: Thursday, £223; Friday, £222 10s.; Monday, £231; Tuesday, £231 15s.; Wednesday, £236 15s. *Three Months*: Thursday, £223 10s.; Friday, £222 15s.; Monday, £231 10s.; Tuesday, £232 10s.; Wednesday, £237 5s.

Spelter.—The market for this metal continues steady and firm, with values but little changed from those recorded last week. Consumption is fairly well maintained, but fresh buying on the part of consumers is small, and, furthermore, producers in Belgium have shown more inclination to meet the demand. Current quotations:—*Ordinary*: Thursday, £32 13s. 9d.; Friday, £33; Monday, £33 2s. 6d.; Tuesday, £33 6s. 3d.; Wednesday, £33 6s. 3d.

Lead.—Values in the market for soft foreign lead are, at the moment, without perceptible movement, buyers maintaining an attitude of caution on entering into any fresh commitments. It is somewhat surprising that values have for so long been maintained at their present high level, and unless speculators again step in with the object of forcing prices still higher, it is difficult to see how a decline can be prevented. Present quotations for lead are out of all proportion to the true value of the metal, and are certainly not justified by the demand, which remains on a moderate scale. Current quotations:—*Soft foreign (prompt)*: Thursday, £30 5s.; Friday, £30 5s.; Monday, £30 10s.; Tuesday, £30 15s.; Wednesday, £30 15s.

Personal.

MR. ROBERT SMEATON, manager of the refining department of the Palmer Shipbuilding & Iron Company, Hebburn, who has been appointed general manager of Palmers (Swansea) Dry Dock Company, Limited, has been the recipient of a presentation from the officials and men.

MR. FRANCIS W. ROWE has recently resigned his position as chief chemist and metallurgist to Messrs. Mather & Platt, Limited, of Manchester, in order to take up a similar appointment with Messrs. David Brown & Sons (Huddersfield), Limited, the gear specialists.

Patent Specifications Accepted.

Particulars of complete specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of 27, Chancery Lane, London, W.C.2. Printed copies of the specifications in the following list are now on sale:—

206,565. TULLIS, W. W., & MINERALS SEPARATION, LIMITED. Concentration and preparation for smelting of iron ores.

206,624. MARKS, E. C. R. Hydraulic foundry moulding machine.

MR. J. H. MARSDIN gave a lecture to the members of the Sheffield File Trades Technical Society last week at the Department of Applied Science on "The Commercial Advantages of a Standard File-Steel."

Company News.

Hordern, Mason & Edwards, Limited, Vesey Street, Birmingham.—Capital £16,000 in £1 shares. Engineers, etc.

United Wire Works, Limited.—Dividend, 7½ per cent., free of tax, on ordinary for year; carry forward, £5,252.

E. Greenwood & Company (Brassfounders), Limited, Elland.—Capital £2,000. Directors: E. Greenwood and W. Huby.

Shotts Iron Company, Limited.—Ordinary dividend, 10 per cent., free of tax; new ordinary shares receive one-third of this amount.

J. & E. Hall, Limited.—Net profits, £66,144; brought forward, £11,830; final dividend, 7½ per cent., on ordinary shares, making 10 per cent. for year; carry forward, £12,974.

Federated Engineers (Ireland), Limited.—Capital £2,000. Directors: F. E. Jones, C. W. Cresswell, A. L. McColl, J. H. Bance, and J. B. Corrie, 15, Victoria Street, Westminster, London, S.W.1.

Kenshep Metal Company, Limited, St. Stephen's House, Victoria Embankment, London, S.W.—Capital £500. Iron and steel merchants, etc. Directors: A. H. L. Shepherd, N. Kenyon, and L. W. Fyson.

Birmingham Aluminium Castings (1903) Company, Limited.—Balance of profit and loss, £10,945; amount brought in, £23,757; total, £34,702; dividend, 6 per cent., free of tax, for year on ordinary; carry forward, £22,723.

Wm. Cooke & Company, Limited.—Transferred from reserve funds to credit of profit and loss account, £40,000; ordinary dividend, 2½ per cent., £4,625, paid July 5; balance at credit of profit and loss account, £11,437; carry forward, £6,812.

Hughes-Johnson Stampings, Limited.—Loss for two years ended August 5, £2,104; brought forward, £1,290; transferred from reserve, £12,500; dividends paid, 7½ per cent., free of tax, and 5 per cent., free of tax; carried forward, £1,186.

Robert Sorby & Sons, Limited, 139, Norfolk Street, Sheffield.—Capital £25,000 in £1 shares (5,000 6 per cent. cumulative preference), to adopt an agreement with Hattersley & Davidson, Limited, tool manufacturers, etc. Directors: A. Davidson (permanent governing), W. E. Pickford, H. Padley and A. Goldthorpe. Secretary: W. E. Pickford.

South Durham Steel & Iron Company, Limited.—Profit, £182,109; brought forward, £118,062; total, £300,171; deducting interest on debenture stock to September 30, 1923, £13,500; dividend on 6 per cent. cumulative preference shares, £13,500; depreciation, £30,000. Ordinary dividend, 2s. per share, £35,000; provision for dividend on 6 per cent. cumulative preference shares, £4,500; carried forward, £203,671.

Cargo Fleet Iron Company, Limited.—Balance of profit at September 30, 1922, £176,693; profits for 1923, £96,945; depreciation, £30,000; debenture interest, £40,989; balance, £202,649; £5,700 4½ per cent. first debentures cancelled; carried forward, £202,649. Report for 1922: Balance of profit at September 30, 1921, £202,845; 5 per cent. dividend on ordinary, £50,000; brought forward, £152,845; profits to September 30, 1922, £95,015; depreciation, £30,000; debenture interest, £41,167; carried forward, £176,693; £1,100 4½ per cent. first debentures cancelled.

Catalogues Received.

Foundry Requisites.—The November issue of the "Pneulec News" is being circularised. This month's issue is mainly devoted to the requirements of the core shop.

Electric Hoist Blocks.—We have received from Messrs. Herbert Morris, Limited, of Loughborough, a booklet (M 687) which is of considerable interest for foundrymen, as transport considerations are now so often being discussed in connection with moulding machines and cupolas as separate entities and as a general foundry proposition. Obviously, to discuss the question intelligently, one should make an effort to appreciate the possibilities of each section. In the catalogue under review, the cupola proposition is dealt with by a combination of bogey wagons and an electric hoist. The case of the molding machine, though not specifically mentioned, one can visualise a monorail system. We would suggest that foundry transport is sufficiently important to warrant a catalogue exclusively devoted to the subject. Most of the essentials are indicated in this book, and only a certain amount of elaboration is required. We understand the catalogue is being circularised to the trade, and foundry managers would be wise to take steps to secure a copy.